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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. VI.

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REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.

REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH

DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY, F.R.S.E.

ONE OF THE NATURALISTS OF THE EXPEDITION

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By Professor Richard Hertwig.

(*Received February* 1, 1882.)

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By William A. Herdman, D.Sc., F.L.S., F.R.S.E., Professor of Natural History in University College, Liverpool.

(*Received November* 1, 1882.)

EDITORIAL NOTE.

THE first Memoir in the present volume is a Report on the ACTINIARIA of the Expedition, by Professor Richard Hertwig, of Koenigsberg.

This Report is not complete, in so far as it does not embrace the whole of the Challenger collection. A considerable number of specimens did not reach Professor Hertwig till some time after he had completed the examination of the collection originally sent to him, indeed, not till the present paper was in type. Professor Hertwig has kindly undertaken to prepare a short supplementary Report on the additional specimens here referred to.

The Memoir has been translated from the German by Miss Nellie Maclagan.

The second Memoir is the first part of a Report on the TUNICATA of the Expedition, by Professor W. A. Herdman, of University College, Liverpool.

As Professor Herdman had completed the examination and description of the Ascidiæ Simplices, he consented to the separate publication of this portion of his Report.

The second part of his Report, which will consist of a description of the Ascidiæ Compositæ and the Pelagic Tunicates, will, it is hoped, be ready for publication within a year from the present time.

The above Reports form respectively Parts XV. and XVII. of the Zoological Series. Part XVI. was published in Vol. V., Zoology.

JOHN MURRAY.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the ACTINIARIA dredged by H.M.S. Challenger during the years 1873–1876. By Prof. RICHARD HERTWIG.

INTRODUCTION.

IN investigating the Anthozoa the majority of earlier naturalists were content to give the most exhaustive description possible of the parts which are externally visible in the living animal, and of the skeleton where such a structure existed; on the other hand, they only went slightly into more exact anatomical details, as the observation of these presented great difficulties. The majority of the Anthozoa are not sufficiently transparent to allow of the recognition of the form and arrangement of the organs in the living animal, whilst after death they are so contracted that all the parts become misplaced in many ways and pressed one against the other, and can only be demonstrated, with great care, by means of knives and scissors. Up to the present time the systematic survey and characters of the orders, families, and genera are founded upon external characteristics which are of less morphological importance.

In this way many errors arose, which have only become intelligible from the work of the last decades. Following the steps of Agassiz (Contrib. to the Nat. Hist. of the United States, vol. iii.), Moseley (Phil. Trans., vol. clxvi. pt. 1, p. 91, 1876; vol. clxviii. pt. 2, p. 425, 1878) has shown in the most convincing fashion that many hydroid polyps which form skeletons have been long placed among the reef-forming corals, and that, moreover, in consequence of the skeletal formation alone having been taken into consideration, many Octocorallia have been disconnected from their natural systematic place, and united to forms entirely remote. It cannot by any means be asserted that

recent discoveries have led to the exhaustion of the more comprehensive reforms of the system of Corallia, as up to the present time we only know the structure of the soft parts of the body, especially of the septa, from a comparatively small number of species, and our knowledge, even of such forms as have been most thoroughly investigated, is far from satisfactory.

This also holds good for the soft-membraned Anthozoa, the Actiniaria or Malacodermata. In this section the structure and arrangement of the septa are of the highest importance for the proper comprehension of the structure; they will probably require to be taken pre-eminently into consideration in the classification, not only of the Actiniæ but also of the other Hexacorallia. But how little do we know on this point. In a recently published work (Studien zur Blättertheorie, Heft i., die Actinien, Jenaische Zeitschrift, Bd. xiii. p. 457, 1879) my brother and I have tried to show that all the important characteristics have hitherto been properly estimated only in a treatise by Schneider and Rötteken (Ann. Mag. Nat. Hist., ser. iv., vol. vii. p. 437), and that, on the other hand, both v. Heider (Sitzungsber. d. Kaiserl. Acad. z. Wien, Math. Nat. Classe, Bd. lxxv., Abth. 1, p. 367, 1877), in his otherwise very elaborate anatomy of *Sagartia troglodytes*, and Jourdan (Annales d. Sciences Nat., Zool., ser. vi., t. x., No. 1, 1880), in his treatise on the Actiniæ of Marseilles, remain far behind the two first-named naturalists. As, however, we have only a short report in a preliminary publication on the researches of Schneider and Rötteken, which extend over a large number of species, it is impossible to make any systematic use of their material, and therefore the number of more detailed anatomical studies of Actiniæ, which, taken from different species, would enable us to form an exhaustive plan of the variations of the type common to all, is still incomplete. These anatomical studies we must have before we can deem it possible to settle an accurate point of view from which to determine the relations of the Actiniæ both to each other and to the other Anthozoa.

Since it appeared to me a grateful task to make a beginning myself in the direction just mentioned, I accepted with pleasure the offer made to me to undertake the working out of the Actiniæ collected by the Challenger Expedition. I wish at the same time to express my most hearty thanks to the late director of the Challenger Commission, Sir Wyville Thomson, and his first assistant and successor, Mr. John Murray, for the great liberality with which they placed the rich material collected at my free disposal.

Before going into a description of the separate species, I think it advisable to determine in a few words the requisites, which, according to my view, ought to be fulfilled by the anatomical description of an Actinia if this is to be of any systematic value. I shall therefore preface the description by a sketch of the structure of this animal, in which I shall lay stress upon the points which are most subject to variation, and to which the special attention of the describer must be directed. Such an attempt is also to be recommended for the further reason that in this way the reader will at the same time

become familiar with the nomenclature, which, taken partly from earlier authors, and founded to some extent upon my own observations, will be adopted in the following pages. I shall also be able to interweave short remarks upon the most serviceable methods of investigation.

The body of the Actinia is shaped like a hollow cylinder, which is usually very long in proportion to its breadth, but which can also be shortened to a discoid form under certain circumstances. It is limited by two terminal surfaces, the "oral disk" or "peristome," and the "pedal disk" or "base," whilst the body wall corresponding to the outer surface of the cylinder is termed the "mural layer," or shortly, the "wall"; the wall is usually separated from the pedal disk, always from the oral disk, by a sharp margin, the two surfaces here meeting at a right or even at an acute angle; the wall occasionally passes gradually inwards into the base, in such a way that we cannot speak of a separate pedal disk.

Towards its periphery the oral disk bears the tentacles, which are simply hollow evaginations of the disk. Besides these "marginal" tentacles there are also "circumoral" tentacles, which are united in a corona round the oral opening, and "intermediate" tentacles, which occupy a position between the oral opening and the margin of the disk. As the first are always present, and the last two only exceptionally, those may be termed the "primary" or "principal" tentacles, these the "secondary" or "accessory" tentacles.

The oral opening, placed in the middle of the oral disk, leads into a tube which hangs down a little way into the hollow space of the body, and in the older descriptions was held to be a stomach, a name which we may now suitably abandon and replace by the term "œsophagus." This ends before it reaches the pedal disk in a free margin, and communicates by a wide opening, the "gastric orifice" or "cardia," with the large hollow space which occupies the inside of every Actinia, and is developed from the primitive intestine of the gastrula, whilst morphologically and physiologically it replaces the intestine and body cavity (enterocœle) of the bilaterals. Leuckart's term "cœlenteron," or "cœlenteric space," is therefore specially appropriate to the Actiniæ.

The œsophagus hanging down in the cœlenteron is fastened to its place by the numerous septa (sarcosepta, Hæckel) which spring from the oral disk, wall, and pedal disk, and are attached superiorly to the œsophagus, whilst they end in a free margin below. They therefore divide the peripheral part of the cœlenteron into simple radial chambers, which are closed where they surround the œsophagus and where they pass into the hollow spaces of the tentacles, but which open downwards between the free margins of the septa into the "central stomach," *i.e.*, into that part of the cœlenteron which lies under the œsophagus and is no longer divided into chambers by the septa.

All the above-mentioned walls and septa of the body of the Actinia are lamellæ of no great thickness, and in many species the wall only is a tough sheath. The firmness of the lamellæ depends upon their fundamental substance of connective tissue,

which, according to the degree of their histological differentiation, may be homogeneous and not enclosing cells, homogeneous and enclosing cells, or, finally, fibrous and containing cells. The framework of connective tissue gives us an accurate figure of the corporeal form of the Actinia even when the epithelial parts have been removed by maceration; from the standpoint of the "Blättertheorie," it must be termed the middle layer of the body or mesoderm.

All the lamellæ of connective tissue are covered on either side by a single layer of epithelial cells, which are distinguished by extraordinary length and thinness, and may, moreover, be placed in different categories according to their different functions. The most usual form is seen in the "supporting cells," in which, despite their fineness in an isolated condition, we can recognise a distinct, triangular, basal expansion. The most common after these are the "urticating cells" and "gland cells." In the former the body is expanded by the presence of the thread, in the latter it is distended by glandular secretion stored up in it. The form of the nematocysts, and the nature of the thread contained in them is not the same everywhere, and may, perhaps, some day become of systematic importance. The glandular secretion is also of different kinds; it sometimes fills the body of the cell, as a homogeneous, glassy mass, sometimes it is deposited as a mass of closely compacted granules, greedily absorbing colouring matter. The fourth form of cells is that of the "sense cells," which have the same fine, filamentous nature as the supporting cells, from which, however, they can be distinguished in an isolated condition by their central end giving off two or more fine nerve threads, which have a tendency to become varicose.

With the exception of the glandular cells, all the cells bear appendages at the peripheral end; the sense cells, and probably also the urticating cells, have fine, long, tactile bristles, of which each cell usually possesses only one; the supporting cells bear a bunch of cilia, or a simple flagellum. Ciliated cells and flagellate cells may be present in the same animal, *e.g.*, in most Actiniæ the ectodermal epithelium is made up of the former, the endodermal of the latter, whilst in *Cerianthus* we find only flagellate cells. We have as yet no satisfactory knowledge of the manner in which the two forms of cells are distributed among the Actiniæ.

The epithelial coverings are derived immediately from the two primitive layers of cells of the gastrula larva, the endoblast and the ectoblast, and in the developed animal are therefore to be distinguished as separate body layers, as endoderm and ectoderm, even when they hardly vary in their histological character. The ectoderm covers the outer surface of the body and the inside of the œsophagus; the endoderm covers everything else, *i.e.*, the inner wall of the whole cœlenteron, and the inner spaces of the tentacles. The supporting lamellæ of the wall, of the œsophagus, &c., are therefore covered with ectoderm on one side and with endoderm on the other; the septa only form an exception, as they bear endodermal epithelium on both sides.

Among the histological elements of the Actinia we must finally mention the muscle cells, nerve cells, and reproductive cells; we shall merely discuss the two former here from a general point of view. The muscles originate either from the ectoderm or the endoderm, and usually continue to belong to both these epithelial layers. They consist of flat, fusiform, muscular fibrillæ, to one side of which the cell from which they were originally produced is attached. This latter is usually at the same time an epithelial cell, and with the fibre belonging to it represents an epithelio-muscular cell, or it is a cell lying in the deeper layers of the epithelium, and no longer extending as far as the surface, an epithelial cell, whose peripheral end has undergone retrograde formation, or a subepithelial muscle cell.

The principle of arrangement of the fibrillæ is the same in both cases; they are placed on the borders of the epithelium and the mesodermal connective substance, and form a thickly apposed simple layer, a muscular lamella. The muscles are not strengthened by the deposition of new layers of fibres, but by the "pleating" of the single-layered lamellæ. The underlying connective substance also comes into play, supporting all the folds of the muscular lamella by fine leaf-like processes (Pl. V. figs. 7–10; Pl. VI. figs. 4, 6).

The pleating of the epithelial, or subepithelial muscular lamella, becomes in many cases the starting-point for the development of a third form of the muscular fibres, the "mesodermal" fibres. When the surfaces of the supporting substance, which borders a muscular fold laterally, approach so that here and there they touch and become fused, the connection of the lower part of the pleating with the epithelium is dissolved, and it becomes completely enclosed in the mesoderm (Pl. VII. fig. 8). In this way are found in transverse sections, circular figures, whose periphery is occupied by the divided fibrillæ, whilst the centre contains the muscular corpuscles belonging to it. The transformation of the epithelial muscular elements into mesodermal can go so far that considerable masses of muscles lie in the mesoderm (Pl. IV. figs. 5–8; Pl. VI. figs. 1–3, 5).

In describing the muscles of the Actiniæ we must, therefore, be careful to note whether they are ectodermal, endodermal, or mesodermal, whether they extend simply in a smooth lamella, or are disposed in folds; as we shall see, they present in this way many characteristics of systematic value. This cannot be said of the nervous system, which I only go into here for the sake of completing my description. Nerve fibres and ganglion cells are found, in thoroughly examined Actiniæ, in nearly all the epithelial laminæ, where they form a layer between the bases of the epithelial cells. The layer is extremely thin in the ectoderm of the pedal disk, and usually also in that of the wall, whilst it is very strong in the ectoderm of the tentacles, of the oral disk and of the œsophagus. Nervous elements are usually less frequent in the endoderm, and only produce visible cords in the mesenteric filaments and acontia. We may lay down as a rule, that, where muscular filaments are present, the layer of nervous filaments lies over the former, and is most easily found in that place.

I have as yet only given a general survey of the anatomical and histological parts composing the organisation of the Actiniaria; it now remains for me to discuss the differentiations shown by the histological elements in their nature, distribution, and arrangements in the various parts of the body, and to show how we may thereby acquire a knowledge of the more accurate characteristics of these parts.

The pedal disk does not present much worthy of notice; it has a slightly developed endodermal muscular layer, always running circularly, which is often even wanting; in the centre there are sometimes, but rarely, one or more small openings, through which the water can find entrance and exit; as yet, however, such openings have only been observed where the pedal disk and wall pass continuously the one into the other, which condition is usually described as absence of the pedal disk. Radial furrows may also run on the outside of the pedal disk, and usually correspond to the insertions of the septa on the inside (Pl. IV. fig. 2; Pl. IX. fig. 5). The wall is much more complicated both on its endodermal and its ectodermal sides; on the former there often lies a layer of circular muscular fibres, which appears everywhere as a flat or slightly folded lamella, but is also often more strongly developed in certain places, and forms a special muscular cord acting as a sphincter. The sphincter or circular muscle usually lies immediately below the upper margin of the wall, which it draws together like a bag over the oral disk and the tentacles if the latter require shelter from any threatened danger. A second sphincter, lying further down, may also be added to the upper sphincter.

The nature of the sphincters varies greatly. We talk of a "diffuse" sphincter when it merely arises from repeated pleatings of the muscular lamella; because in that case it is not sharply defined at the upper and lower margins (Pl. V. fig. 8), it does not strike the eye in looking at the surface, and is shown in transverse section only by the local thickening of the wall in whose substance it is completely embedded. A "circumscribed" sphincter is formed when the pleated muscular mass projects above the inner surface of the wall, with which it is connected only by a narrow band, so that an annular swelling arises which is easily observed both in looking at the surface and in transverse section (Pl. VII. figs. 2, 4). Finally, in the "mesodermal" sphincter, the muscles have left their original position in the epithelium, and are completely hidden in the supporting substance, which consequently increases doubly or trebly in thickness (Pl. VII. fig. 7; Pl. VI. figs. 1–3).

The complete absence of the sphincter is comparatively rare. I have only observed it in a few species (*e.g.*, in the representatives of the genus *Corallimorphus*), almost invariably animals which are not capable of contracting the upper margin of the wall over the oral disk. This is, however, also the case in animals with a weak sphincter, such as the Antheadæ. On the other hand, the existence of a strong circular muscle can often be inferred with tolerable certainty from a high degree of contraction. The capacity for concealing the oral disk plays an important part in the systematic division of the

Actiniaria; this is generally most inappropriately expressed by the term "retractile tentacles." It would be decidedly more rational to make the anatomical reason, and not the physiological appearance, of systematic value. We shall therefore talk of Actiniaria without sphincter, and of Actiniaria with weak and with strong sphincter, and further distinguish in the latter case whether the muscle is endodermal or mesodermal.

The systematic value of the circular muscle does not end here, as it furnishes a character not to be undervalued, for determining the species. The extraordinary variations of the circular muscle are shown by a glance at Plates VI. and VII.; in the endodermal forms the shape and mode of branching of the muscular folds vary, in the mesodermal the shape and grouping of the bundles formed by the fibres, and also their position in the more superficial or deeper layers of the wall. I lay stress upon this point, as the circular muscle can be examined in the preserved animals even when their state of preservation is not very favourable, and because, moreover, a small piece of the wall, which can be cut away without essential damage to the whole animal, is sufficient for such an investigation.

Muscles, especially longitudinal muscles, are rarely present on the ectodermal side of the wall, whilst, on the other hand, it is not unusual to find "marginal spherules" and different forms of papillæ. The marginal spherules ("bourses marginales," Hollard, Ann. d. Sci. Nat., Zool., ser .iii., t. xv. p. 257) follow immediately outside the tentacles, and are evaginations of the mural membrane, just as the tentacles are evaginations of the oral disk. All the layers of the body participate in the evagination, though the ectoderm alone undergoes modification of its structure, being extraordinarily rich in nematocysts.

The papillæ, to which such importance was attached in earlier investigations of the Actiniæ, are formations of very subordinate value; they are caused by mere local growth of the supporting plate, and are not distinguished by a single special property of the covering epithelium (Pl. VIII. fig. 4). Hence the observer often found himself on the horns of a dilemma when he had to decide whether papillæ were present or not. A smooth surface may become papillose in consequence of contraction, and, on the other hand, small papillæ may disappear when, as often happens, the Actinia becomes distended like a drum. It would, therefore, be better in future only to make the papillose or smooth nature of the membrane of value in distinguishing species, or at most of genera, and to disregard it in the formation of larger divisions.

The comportment of the epidermis appears to me much more important. The majority of the Actiniæ have a smooth surface, on which particles of mucus become secreted when the animal is irritated; histological investigation then shows an active ciliated epithelium composed of extremely long, thin cylindrical cells. Besides this, two varying modifications of the integument have already been specially observed. In the one case, in *Cerianthus*, the epithelium is covered externally by a tough membrane, consisting of mucus, nematocysts, and scattered foreign bodies, which can be stripped off, but which

is rapidly regenerated, and in which the animal is concealed as in a sheath; in the other case there is a membrane present which cannot be stripped off, and which gives the surface a rough, bark-like appearance; this has received the very unsuitable name of "epidermis." In fact, we have to deal with a cuticular formation. In the most simple cases, where the epithelium does not bear cilia, it is covered loosely by a thin, irregular fibrous membrane, outside which is a layer of mucus, traversed by all sorts of foreign bodies (Pl. VIII. figs. 1 and 6). This cuticular secretion rarely becomes a broad, stratified mass resting firmly on the epithelium, and recalling completely the cuticula of the worms (Pl. XII. figs. 1 and 2).

The wall can also be traversed like the pedal disk by furrows, which run in a longitudinal direction from the base to the border of the oral disk, and likewise correspond to the septa.

The possible presence of "cinclides" must finally be taken into consideration; this is the name applied by Gosse (Actinologia Britannica, 1860) to openings in the wall through which water and the acontia, which we have still to describe, can be ejected from the inside of the body. Such cinclides can be observed in *Calliactis parasitica*, even in spirit specimens, where they are arranged in a circle at a little distance from the pedal disk. In other cases, on the contrary, we see that acontia issue from the interior of the living animal through the wall, but it is impossible to find performed openings, even if we take a protruded acontium as guide. Whether the opening is difficult to find out, or whether it is not performed, but arises afresh each time by rupture, as v. Heider assumes, must still be regarded as an open question. That is a point which essentially lowers the systematic value of the cinclides. Gosse has certainly made light of the question, and assumed the presence of cinclides wherever he noticed the passage of the acontia, even though he did not find any openings. Such a method of treatment, however, can be properly carried out only in the living animal, as spirit material leaves the question undecided.

The oral disk is furnished on both sides with muscular fibres, running radially on the ectodermal side, circularly on the endodermal; the latter are connected immediately with the muscular fibres of the wall, with which they form a continuous layer. Whilst the endodermal muscular fibres possess no further interest, and comport themselves, so to speak, in the same manner throughout, the development of the ectodermal muscular fibres is subject to numerous variations, which, like the nature of the sphincter, can be turned to good account for more accurate determination of the species. In all cases we must distinguish whether the muscular fibres maintain their original place in the epithelium, or whether they have passed wholly or partially into the mesoderm. We must, moreover, pay attention in the first instance to whether the muscular lamella is smooth or pleated, and in the second instance to the form and arrangement presented by the mesodermal bundles of fibres.

The same questions recur in the tentacles, which are merely evaginations of the oral disk. Here the endodermal circular muscular fibres are always uniform, whilst the ectodermal longitudinal cords vary. Moreover, there are usually, if not always, openings present in the tentacles through which water is ejected when the animal becomes contracted; they occupy the point of the tentacles, and are easily observed in the living animal. In order to find them out in the spirit material I fastened a tentacle, which had been cut off, to a tube and inflated it with air under water; if an opening were present the air bubbled out through it.

According to their shape the tentacles are distinguished as "knobbed," "club-shaped," "branched," "conical," &c., terms which do not require further explanation. Their mode of arrangement, of which I shall speak in connection with the septa, is also of importance. On the other hand, their length and shortness is a characteristic which is not capable of exact definition, and cannot be determined with any certainty in the spirit specimens, as it is impossible to judge to what extent the length has been influenced by a greater or lesser degree of contraction. This characteristic cannot, however, be dispensed with for systematic purposes.

Whether the tentacles in the Actiniæ may be entirely wanting, without being morphologically replaced in some way or another, seems to me questionable, as no such case is known up to the present time. The tentacles may, however, undergo a peculiar retrograde metamorphosis, progressing so far that only the terminal opening is left in the form of a fissure, which is enclosed by thickened lips, and, lying in the periphery of the oral disk, shows the spot where we might have expected to find the tentacle. I have observed different stages of this retrograde formation in species of Actiniæ coming from great depths. We see the beginning of it in *Polysiphonia tuberosa* (Pl. II. figs. 7, 9), also *Sicyonis crassa* (Pl. IV. fig. 4), and the advanced stages in *Polyopis striata* (Pl. II. fig. 11), and *Polystomidium patens* (Pl. V. fig. 6).

The oral opening is only exceptionally round; it has usually the form of a fissure whose longitudinal diameter lies in the same direction in all Anthozoa. It is therefore of the greatest importance for distinguishing the axes which may be drawn through the body of the Actiniæ. If the Actiniæ were animals possessing perfect radial symmetry, then the longitudinal axis, determined by its passing through the oral and aboral poles, would be the only constant one, and all radial axes lying perpendicular to the longitudinal would then be perfectly equivalent to one another. By the constant form of the oral opening, the radially symmetrical fundamental form becomes more definite, and is at least transformed into the biradially symmetrical form. In all cases, two of the radial axes strike us as specially distinguishable, the sagittal axis running in the direction of the oral fissure, and the transverse axis perpendicular to it. We can even exceptionally recognise a dorsal and a ventral side at the ends of the sagittal axis, and a right and a left side at the ends of the transverse axis, and hence the

biradially symmetrical fundamental form is transformed into the bilaterally symmetrical. I lay great stress upon this apparently unimportant consideration of the form of the mouth, as it is the expression of a fundamental character in the architecture of the body of the Actinia, which is, moreover, the standard for the configuration of the œsophagus and the position of the septa.

The œsophagus is a sac, flattened in the transverse direction, and open below and above; it is furnished with circular muscular fibres on its endodermal aspect, whilst it has exceptionally longitudinal fibres on the ectodermal aspect, the one turned towards the lumen of the tube. Its walls are solid, and only two instances have been observed in which they have openings leading into the radial chambers. In the typical Actiniæ the lower end of the tube is produced into two long lappets, which fall in the sagittal axis and consequently under the two corners of the mouth, or, what is the same thing, where the two wider sides of the tube meet each other. The inner side of the œsophagus is covered with regularly arranged longitudinal furrows, of which two, corresponding to the angles of the mouth, are conspicuous by their special breadth and depth. These furrows or grooves lead from the oral angles to the œsophageal lappets, on which they run up to the end; they constitute half canals, which remain open, even when the two wider sides of the œsophagus are pressed firmly against one another, and then become two canals leading into the stomach (Pl. I. figs. 2, 5).

As the œsophageal grooves pass at the one end on to the œsophageal lappets, so they are bounded at the other end by two lip-like swellings, which enclose the oral angle: these are simply strongly-developed papillæ, which are also found in varying number on the oral margin, and indicate the ends of the longitudinal ridges rising between the smaller longitudinal furrows of the œsophagus. The Zoantheæ and Ilyanthidæ form an exception to what has been said; the former have only one distinct œsophageal groove, whilst in the latter there are none worth mentioning. We meet here with differences, which are correlated with the structure and arrangement of the septa.

The septa are supporting plates formed of connective tissue, which are covered on both sides by endodermal epithelium, bear muscular fibres on both sides, and thus become very important organs for the contraction of the body. In those Actiniæ, which still preserve the most primitive structure of the septa, *e.g.*, the genus *Corallimorphus*, we can distinguish only two systems of muscles; the fibres run for the most part longitudinally on the one side, transversely on the other, forming in both cases a smooth, only slightly pleated layer. Considered more closely, the former spring from the pedal disk and the lower parts of the wall, and converge towards the œsophagus and central parts of the oral disk, whilst the latter arise from the whole length of the wall and are inserted into the oral disk and the œsophagus. In the majority of Actiniæ the longitudinal layer is differentiated by local, specially rich development of muscular fibres and repeated pleating into a special more or less sharply-defined muscle, the retractor, which projects

to a varying extent above the surface of the septum, and shows many variations in the details of its constitution; a second specialised but much weaker cord stretches along the wall, close to the origin of the septum. As the retractor in transverse section is placed on the septum like a pennon, Schneider and Rötteken have given it the name of "muscular pennon." On the other hand, the "parietobasilar" muscle is differentiated from the transverse muscles; it lies in the angle between the pedal disk and wall, into which it projects with a crescentic margin, like the plica semilunaris in the corner of the eye. It extends to different distances up the wall and towards the central point of the pedal disk. It originates from the transverse muscular layer, by a process of pleating which is beautifully shown in *Leiotealia nymphæa*. As the muscular fold here still lies loosely on the septum, we can pass a needle into the pouch-like interspace. Apart from the parietobasilar muscle, the transverse muscles are most strongly developed in the upper third of the body of the Actinia (Pl. II. fig. 6; Pl. IV. fig. 9; Pl. VII. figs. 5 and 12).

As the two surfaces of a septum differ from and are unequal to one another in the arrangement of the muscles, there are predispositions to a peculiar arrangement of the septa which, with few exceptions, is found in all Actiniæ, viz., that the septa are united in pairs, so that we cannot speak appropriately of single septa but of pairs of septa. The equivalent sides of the septa of the pair, *i.e.*, the sides in which the muscles run in the same direction, are turned towards each other. As a rule, it is the sides with the longitudinal muscles, and only in two pairs the sides with the transverse muscles. These two pairs of septa occupy a perfectly fixed position in the body of the Actinia, and may consequently be used for fixing direction, on which account we shall name them the "directive" septa. The directive septa correspond to the œsophageal grooves, and are fastened to the œsophagus from the oral angle downwards to the end of the lappets of the œsophagus. They constitute the principal reason why such stress should be laid on the form of the mouth, and they themselves contribute very essentially to a more clear expression of the biradially symmetrical character of the body of the Actinia.

The history of the development of the septa will help us to understand some further characteristics of their arrangement. We see from it that the septa of a pair have generally a common origin, and that only the first six pairs form an exception to this rule. The most recent researches show that the septa of the first six pairs appear independently and at different times, and that they become united secondarily in pairs; as they are placed first, and according to a special principle, it is appropriate to distinguish them as "principal" septa from the others, the "accessory" septa. In some cases (in *Sagartia*, *Phellia*, *&c.*) they are permanently recognisable from the fact that they only are inserted into the œsophagus; usually, however, this peculiarity is shared by numerous accessory septa, and they are then merely distinguished by their somewhat larger size. The difference of size may, however, be almost equalised, which makes the determination of the principal septa difficult. This is, however, made easier by the fact that the two pairs

of directive septa also belong to the six pairs of principal septa. These are easily found as they lie at the opposite ends of the oral fissure, and thereby furnish us a fixed point for the determination of directions. The remaining four pairs of principal septa are distributed in the space in such a way that each two are found right and left from the oral fissure at equal distances from one another and from the directive septa. The six pairs of principal septa form together a regular six-rayed star.

In an Actinia with the first six pairs or the first twelve septa, the space round the œsophagus is divided into twelve radial chambers, of which six lie inside the pairs and six between the adjacent pairs. The former are the "intraseptal" spaces or "inner" spaces, the latter the "interseptal" spaces or "interspaces." Whilst the inner spaces remain unaltered, the interspaces grow, and the accessory septa develop in them in pairs, and in an arrangement which will not undergo any change. This definite arrangement may be shortly characterised as follows:—A pair of septa lie in the middle of each interseptal space: if we term the principal septa septa of the first order, or shortly, "primary septa," these are the six pairs of septa of the second order, or "secondary" septa. They nearly equal the primary septa in size, and, except in the Sagartidæ, are fused with the œsophagus; they divide the interseptal spaces into three parts: (1) an intraseptal space of the second order, and (2) two interseptal spaces of the second order. Then follow twelve pairs of septa of the third order in the interspaces between the primary and secondary septa, twenty-four pairs of septa of the fourth order in the interseptal spaces so formed, and so on. The septa usually decrease in size, for whilst the first, which arise from the pedal disk and from the wall, are inserted into the oral disk and the œsophagus, as far as the lower margin of the latter, the succeeding pairs gradually extend to a less distance down the œsophagus, then fail to reach it at all, and finally are attached only to the oral disk at a distance from its centre. The same process is repeated at the pedal disk. The older septa project nearly as far as the centre of the pedal disk, the younger only a little way inwards from the periphery. As the size of the septa undergoes very gradual modification, we can merely place them in two categories, "imperfect" septa, which do not reach as far as the œsophagus, and "perfect" septa, which are fastened to the œsophagus. After what has been already said, it is unnecessary to add that all the pairs of secondary septa have longitudinal muscles on the faces which are turned towards one another, and transverse muscles on the faces which are turned away from one another.

Methods of inquiry, differing according to the size of the animal, are to be recommended in order to recognise the above-mentioned conditions. Small specimens may be examined in transverse sections taken through the œsophagus, by which we survey the whole arrangement of the septa at a single glance. Care must be taken, however, that the section actually passes through the œsophagus and not somewhat through the oral disk, which in contracted animals often reaches deep down into the interior. For example, it appears to me not improbable that v. Heider gave too high a number of complete septa in *Sagartia*

troglodytes, because he mistook sections through the oral disk for sections through the œsophagus. To avoid such errors it is only needful to bear in mind that the oral disk has strong radial ectodermal or mesodermal muscles, whilst the œsophagus is almost always devoid of muscles on its ectodermal side. Oral disk and œsophagus can be also easily distinguished by the different character of the epithelium.

There are, however, numerous other difficulties attendant on the interpretation of transverse sections, as the principles of arrangement are often not visible from the large number of the septa which are pressed together and displaced by contraction. Such sections are, therefore, unadvisable in large forms, and especially in those of which we have only a single specimen at our disposal; in these cases dissection with knives and scissors is preferable. For this purpose we find out the oral angle, and open the intraseptal space of a pair of directive septa by an incision into the œsophagus; when we have cut through the base of the septum along the œsophagus, oral disk, wall and pedal disk, we have a fixed starting-point, and are then able to detach the septa pair by pair, and arrange them in series one after another. Any one at all versed in the matter will soon know from the size of the septa, from the distance of the directive septa, and from the way in which the septa follow one another, when he lights upon the next pair of principal septa: he then knows that he has examined one-sixth of the body, and does not require to investigate the remaining five-sixths, as the same formation is repeated in the usual forms of Actiniæ.

Another mode of preparation, which takes still less time, consists in detaching the pedal disk in such a way that the bases of the septa still remain in it. By this means we can easily see the arrangement of the septa, but not distinguish, however, how many of them are complete.

When we have separated and prepared the pairs of septa in the manner described, we also get a view of the distribution of the tentacles which are evaginations both of the intraseptal and the interseptal spaces. As a rule, each intraseptal space has only a single tentacle, while the number borne by the interspaces may be greater. This is by no means remarkable, as the interseptal spaces are seats of active growth. In those Actiniæ, in which there is a continual increase in the number of septa in the interspaces, there is also a continuous evagination of new tentacles, and as the formation of the latter precedes that of the former, it may happen that numerous tentacles are already present, whilst the septa belonging to them are either entirely wanting or their rudiments only perceptible. In *Antholoba,* for example, the innumerable tentacles of the umbrella margin belong chiefly to the interspaces (Pl. I. fig. 9).

Like the septa the tentacles differ in age, so that we can distinguish tentacles of the first, second, third order, &c. This often causes distinction in size, which is best seen in the Corallimorphidæ, where the entire arrangement of the septa is reflected in the size of the tentacles (Pl. II. figs. 1 and 3). The six largest tentacles belong to the primary intraseptal spaces, the next six, which are only a little smaller, to the

secondary intraseptal, then follow the twelve tentacles of the tertiary intraseptal spaces which are visibly smaller, whilst the twenty-four last tentacles communicate with the interseptal spaces. The difference in the size of the tentacles is, however, rarely so marked as this, for a partial or complete equalisation in their size usually takes place at an early period of development.

When there are a large number of tentacles there is no room for them in a single row, but they are forced to form several rows, of which the inner are the oldest, the outer the youngest. All the tentacles of the same circle are essentially of the same size, but a difference in size may arise between different circles, which is shown by the innermost, and therefore oldest, tentacles being the largest, the outermost and youngest the smallest. If uniform growth take place in all parts of the body of the Actinia, the whole of the circles are arranged, as may often be seen, in multiples of six. For example, twelve tentacles of equal size form the innermost circle, if it be composed of tentacles of the first and second order; twenty-four, if those of the third order be added to the number; the next circle would then be occupied by the twelve or twenty-four succeeding tentacles of the sequence. There are often, however, numerous variations, caused by unequal growth in the different sextants; for example, the tentacles of the third order may have advanced into the innermost circle in one sextant, whilst in another sextant they remain in the next circle. In this way it may happen that the arrangements of the tentacles and of the septa do not correspond completely, even though they are not directly contradictory, since the tentacles of a later order are, at all events, not larger than those of a preceding order. I only know one exception to this rule, *Polysiphonia tuberosa*, to the description of which I refer the reader.

Hitherto I have only spoken of tentacles which are placed on the margin, and which always remain equivalent to each other even when, changing their position for want of space, they have retreated on to the oral disk, and become apparently arranged in several rows. I have already placed these primary tentacles in opposition to the secondary tentacles, which are associated with the primary in the Corallimorphidæ (Pl. II. figs 1 and 3). They form a system in themselves, and are placed half-way between the peripheral and oral margins of the disk. They correspond only to the intraseptal spaces, and their size is graduated according to the age of the latter. The above-mentioned rule undergoes an exception here, as each intraseptal space communicates with two tentacles, a primary placed on the margin, and a secondary placed on the disk. The Corallimorphidæ are the only exceptions which I have observed, for the Cerianthidæ, which are usually described as Actiniæ with a double corona of tentacles, cannot be considered here because of the aberrant arrangement of their septa, which are not united in pairs, thus rendering the distinction between the intraseptal and interseptal spaces impossible.

The septa bear the reproductive organs, the mesenteric filaments, and in many families

the acontia. During maturity the reproductive organs lie in the supporting plate composed of connective tissue. They form follicles of spermatozoa in the male, separate ova in the female, and both together in hermaphrodite individuals; the youngest ova lie in the endodermal epithelium, which therefore represents the germinal layer, but even older eggs—at least this has been observed in several species—are still connected with the surface of the epithelium, either by means of a conical cord of protoplasm, or by means of a bundle of epithelial cells, at whose base a process of the ovum passes transversely through the supporting lamella.

The mesenteric filaments occupy the free margins of the septa, beginning at the upper end—at the œsophagus in the complete septa—and finishing at a little distance from the lower end. They are formed by the supporting lamella (Pl. V. fig. 5) splitting at the free margin into three laminæ, a middle and two lateral; the former is covered by a streak of epithelial cells, principally glandular, the latter bear extremely fine, small ciliated cells. A visible cord of nervous fibres, which is entirely wanting in the ciliated streaks, runs along the base of the glandular streak. The character of the filament changes lower down, as the ciliated streaks with their supporting plate of connective tissue disappear, and the median glandular streak only remains.

The acontia (Pl. I. figs. 4 and 5) are long filaments, kidney-shaped in transverse section, which spring from the septa at a little distance from the lower end of the mesenteric filaments, lie coiled in the stomach during a state of rest, and are ejected through special openings in the wall (cinclides), or through breaches in the wall, or through the oral opening, when the animal is irritated. Their component parts are: (1) an axial band of connective tissue, (2) an epithelium, chiefly composed of nematocysts, (3) nerves, and (4) muscular fibres lying between the basal ends of the epithelial cells (Pl. XII. fig. 10).

Finally, there are special openings in the septa which connect the separate divisions of the gastric space. There are two forms of such septal stomata. In nearly all Actiniæ we find openings which pierce the septa just where the latter touch the margin of the mouth, and which form together a species of peristomial canal; the upper part of these openings is limited by the membrane of the oral disk, the remainder by the septa, so that they are shut off from direct contact with the œsophagus. More rarely there are other septal stomata, which lie close to the wall, about the junction of the first and second thirds of the body (Pl. VII. fig. 12).

I have hitherto described the anatomical conditions of the septa, as they may be observed in the hexamerous Actiniæ, and probably in all hexamerous corals. It would, however, be very erroneous to assume that what has been said applies to all forms hitherto included among the Hexacorallia; we find, in fact, sundry variations, which I shall place under five different categories, though I do not presume to say that these exhaust all the variations presented in nature.

Among the first group I place those Actiniæ in which there are two pairs of directive

septa, in which the remaining septa are grouped in pairs, but in which six is not the fundamental number for the arrangement of the septa, *e.g.*, *Sicyonis crassa* with sixty-four pairs of septa, and *Polyopis striata* with sixteen pairs. The two directive septa correspond to two distinct œsophageal grooves.

In the second group we find two pairs of directive septa, the single septa are constructed precisely as in the true Actiniæ, but, with the exception of the directive septa, are not united in pairs. I name *Edwardsia* as a type of this group.

In the third division, to which only a single species of those examined by me, *Scytophorus striatus*, belongs, the variation from the typical condition runs in the opposite direction. The paired arrangement of the septa is preserved, but one pair of directive septa is wanting (Pl. XIII. fig. 3).

In the fourth division we can clearly recognise a single œsophageal groove on the œsophagus; the septa inserted at the bottom of the groove may also be defined as directive septa, but it is not possible to point out on them the muscular arrangement found elsewhere. They agree, however, with the other septa, in so far as they have a thin layer of transverse muscular fibres on both sides. This is the case in *Cerianthus*. The fifth division is formed by the Zoanthidæ, in which the septa are paired, but partially in a rudimentary condition.

The plan which I have drawn up here, partly from the observations of others, but principally from my own earlier and later investigations, of the structure of the Actiniæ, allows me to make a few criticisms on the more important systems of Actiniæ already published.

Ehrenberg in his system of the Actiniæ, has made use first and foremost of the presence or absence of the sucking papillæ, then of the openings in the mural membrane, and, finally, of the form, length, and arrangement of the tentacles. The sucking papillæ recur in Gosse's system, though they are made of subordinate importance; they are described by him as hollow papillæ, furnished with a muscular apparatus, by which a vacuum is formed. I have entirely omitted the sucking papillæ in the general description of the anatomy of the Actiniæ, as I have never observed them, even in forms which were capable of incrusting themselves with foreign bodies. I am the more justified in doubting their existence, as Gosse has given no proofs verifying his assertions. Jourdan has lately described something like sucking papillæ in *Bunodes verrucosa*, his "verrues glandulaires," epithelial cones, consisting almost entirely of glandular cells, which press into the mesoderm, and partly form entirely or almost entirely detached mesodermal islands of cells. Here, however, we must consider the fact that, in the case of an extremely papillose surface, the depressions and sinuses between the papillæ may often resemble glands in transverse sections, taken through the wall. I have never been able to convince myself of the existence of glands in *Bunodes minuta*, which does not, however, refute the assertions as to their presence in *Bunodes verrucosa*. It is safer anyhow to consider the adhesion of foreign bodies as brought about, on the whole, not by means of sucking-cups,

but by mucous cells, and nematocysts, and to entirely obliterate the sucking papillæ from the list of systematic characters.

With regard to the cinclides or pores of the wall, which are so extensively used not only by Ehrenberg (Abhandl. d. Berliner Acad., 1832, Phys. Cl., p. 225), but also by Gosse, and still more by Milne-Edwards, I need only repeat what has been already said. They are only distinct in a few forms, are questionable in most cases, and therefore form a characteristic which is practically of no great use. The tentacles form a much more important characteristic than the two already discussed, less on account of their form and size, on which Ehrenberg lays such stress, than on account of their arrangement and relation to the intraseptal spaces, which have hitherto only exceptionally been taken into consideration.

Ehrenberg's system was first essentially improved by Milne-Edwards and Gosse. Milne-Edwards added, to those already made use of by Ehrenberg, some new systematic characters, which undeniably indicated progress. The extended knowledge of species which had meantime been acquired rendered it necessary to take the different nature of the pedal disk in the Minyadinæ, Cerianthidæ, and Ilyanthidæ into account in the formation of the system; we owe to a more exact anatomical knowledge the appreciation of the systematic value of the marginal spherules. On the other hand, it is difficult to understand how Milne-Edwards came to found two great groups, "actinines vulgaires" and "actinines verruqueuses," on such a character as the papillose or smooth nature of the surface of the body, which is in itself unimportant and in no case clearly marked. His mode of expression is by no means well chosen with regard to another point. When, for instance, Milne-Edwards divides the tentacles into retractile and non-retractile, he lays stress upon a secondary point, and overlooks the much more important behaviour of the upper margin of the wall which can be drawn over the oral disk in the former case but not in the latter. This varying action of the wall is the only point of importance, because it is anatomically founded on the structure of the circular muscle.

What I have said about Milne-Edwards is also true, on the whole, of Gosse, as the same distinguishing characters recur in his system, although he uses them in a different manner; in consequence of this last circumstance the genera of Gosse and Milne-Edwards are often not co-extensive. A step in advance is made, inasmuch as Gosse takes into consideration in his descriptions the acontia, which he himself had discovered, but, on the other hand, the inconsistencies of which he is guilty lay the English naturalist open to the gravest criticism. How, for example, does it happen that the smooth wall not pierced by cinclides is made the most important character of the Antheadæ, and in spite of this the genus *Aiptasia*, which has been separated from other genera chiefly on account of the presence of cinclides and acontia, is placed in this family? How can the genus *Phymactis*, whose diagnosis rests upon the character "skin warted," be placed among the Actiniadæ in which the wall ought to be smooth?

The more recent naturalists who have given systematic surveys of the Actiniæ, and among them Fischer, Jourdan, Klunzinger (Korallthiere des rothen Meeres, Heft. i.), and above all Verrill (Proc. Elliot Soc., vi., Comm., p. 69), sometimes follow Milne-Edwards more closely, sometimes Gosse; none of them have brought forward new or comprehensive points of view.

Although the existing systems of the Actiniæ undeniably require a complete remodelling on a new foundation, I have refrained from this at present, as the material investigated by me was insufficient. I only considered it absolutely needful to form some larger divisions anew, in order to express in some measure the conditions of relationship among the forms. I have taken the structure and arrangement of the septa as the fundamental principle, and distinguish six tribes of Actiniaria: (1) Hexactiniæ, (2)Paractiniæ, (3) Monauleæ, (4) Edwardsiæ, (5) Zoantheæ, (6) Ceriantheæ.

I have followed Gosse as far as possible in fixing the limits of the families, but my great endeavour has been to define more sharply the meaningless characteristics hitherto in use, by bringing more emphatically forward the anatomical characteristics predominantly developed in the separate families, such, for example, as the nature of the septa and of the circular muscle, the presence of secondary tentacles and acontia (the latter may appropriately replace the cinclides), and the distribution of the reproductive organs. Thus, I have characterised the family of the Sagartidæ afresh, as I have laid down as essential that they should possess acontia and a mesodermal circular muscle, and that the six pairs of principal septa should be distinguished from the rest by being alone perfect, and not bearing reproductive organs. I found these conditions in a whole series of forms belonging to the *Sagartiæ*, and if other species hitherto placed among them do not agree in these respects, it is impossible that they should remain in one and the same family.

As regards the definition of the species, I found myself in a difficult position. All the specimens of the Challenger material before me were in a strongly contracted condition, so that I could only form a very imperfect idea of their natural shape. Many of them were, moreover, injured in being detached from the underlying substance or by the dredging apparatus. The colour had gone entirely, almost without exception, and the only information on this point was that given by Moseley about the few forms described by him in the Transactions of the Linnean Society. Thus, nearly all the characteristics on which former authors based their diagnoses of species were wanting. Verrill, who has a most comprehensive systematic knowledge of Actiniæ, declares that in such a case all specimens only known in a preserved condition are scientifically of no use; he has therefore laid down as a fundamental principle, that only living forms, or those from which drawings have been taken in a living condition, can be utilised for accurate systematic description.

From this point of view, the Challenger material would have been, on the whole, of

no use. Notwithstanding, I undertook to work it out, and extended my operations over nearly all the specimens, because, according to my opinion, Zoology ought never to take up a point of view, the effect of which would be that she must remain excluded from a large field of knowledge. In such cases it is rather the bounden duty of those who are working out the material to discover characteristics by which the recognition of the species is rendered possible, and this I believe I have achieved. Whoever keeps in view all the points taken into consideration in the description, the structure of the tentacles, of the septa, of the oral disk, of the circular muscle, &c., should find no difficulty or doubt in identifying a form with a living species, taking for granted that he has gained a correspondingly accurate anatomical knowledge of the latter.

In conclusion, let me add a few words as to the state of preservation in which the material for investigation was handed over to me. As all naturalists who have had much to do with Actiniæ know from personal experience, the animals are difficult to preserve, and require special attention in putting up. As such attention could not be devoted to them in the Challenger expedition, many of the Actiniæ did not fulfil the demands made by any kind of accurate histological investigation. I regret especially that many of the specimens had been first placed in chromic acid or chromate of potash, and then in alcohol. These were so dry and friable that they fell asunder like tinder under the slightest pressure; methodical dissection was therefore impossible, especially as even letting them lie for some time in water did not restore flexibility to the body. Preservation in chromic acid and chromate of potash must therefore be avoided, as it offers no advantages for histological investigation.

In many of the Actiniæ, hardened in alcohol, the inner parts were likewise macerated, perhaps because a large number had been placed in too small a quantity of alcohol, or because dilute alcohol had been used. Anyone collecting Actiniæ for examination ought to attend to the following points. In the first place, it is advisable to keep the animals separate till they are completely hardened, in order to prevent them from being flattened while soft by pressing against each other. If this be not done, not only the form but the sculpture of the surface suffers, which was often the case in the Challenger material. In the second place, it is advisable to syringe the inside of the animal with alcohol, placing the nozzle of the syringe through the mouth, or through a hole made in the wall or the pedal disk. On the other hand, cutting or even halving of the living animal is to be objected to, as in that case it is impossible to avoid the destruction of many of the septa, and the parts will be displaced much more than in the ordinary contraction of the animal.

In order to fulfil all requirements exactly, the Actinia before being preserved should be subjected to a process which paralyses the muscles, such as has been previously described by my brother and myself. This, however, requires more time and care than can usually be bestowed by the collector on a single object.

DESCRIPTION OF SPECIES.

ACTINIARIA OR MALACODERMATA.

Polyps with simple unpinnated tentacles and with septa, the number of which is usually a multiple of six; without skeleton. Body moving freely or adhering to supporting substances by means of suction of the pedal disk, rarely firmly fixed. Animals usually solitary, rarely forming colonies.

In the foregoing diagnosis I have placed the nature of the tentacles first as the only thoroughly positive characteristic of the group; it is by this that the Actiniæ are distinguished from the Anthozoa with pinnated tentacles, the Alcyonaria or Octactiniæ. I have been obliged to place second, and to limit the value of the hexamerous arrangement of the septa, to which the chief importance was formerly attached, as the number of the forms in which no settled number or even another number than six is the foundation of the distribution of the septa is continually increasing. I have included the want of the skeleton in the diagnosis, and therefore separated the Actiniæ from the Corals, for practical reasons; the division is not a natural one. There can, however, be no doubt, and this has been settled for some forms by observations, *e.g.*, for *Caryophyllia cyathus* and *Madrepora variabilis* by G. v. Koch (Morphol. Jahrb., Bd. v., p. 316, 1880), that many Corals have the septal arrangement of the Hexactiniæ, and therefore approach this first section of the Actiniaria more closely than the remaining sections, the Paractiniæ, Edwardsiæ, Zoantheæ, and Ceriantheæ.

Tribe I. HEXACTINIÆ.

Actiniaria with paired septa. The septa of each pair are usually provided with transverse muscular fibres on those faces which are turned from one another and longitudinal muscular fibres on those faces which are turned towards one another, with the exception of two pairs of directive septa, which are placed opposite one another, and have longitudinal muscles on the faces turned from one another, and transverse muscles on the faces turned towards one another. The number of the pairs of septa is at least six, usually more, and then increasing in multiples of six. Mouth fissure-shaped; œsophagus with two œsophageal grooves and two œsophageal lappets.

Ehrenberg had the Hexactiniæ and the Corals connected with them in view when he separated his *Zoocorallia polyactinia* with more than twelve radii from the eight-rayed Octactiniæ. In the same way only they can lay claim to the name Hexacorallia bestowed on them by Hæckel (Generelle Morphologie, Bd. ii., 1866). As they form the principal part of the Actiniæ, they have long been taken as types for the remainder. After Hæckel had detached *Cerianthus* by reason of the observations on its development made by Jules Haime, my brother and I pointed out the varying position of the Zoantheæ and

Edwardsiæ. The examination of the Challenger material has further confirmed the correctness of this view, but shows at the same time that the number of the varying types is by no means exhausted.

Most corals will doubtless be placed later on with the Hexactiniæ; perhaps a natural division into forms having a skeleton and forms without skeleton may not be possible, as even the closer limitation of the Hexactiniæ given here does not exclude the possibility of many of their families having more affinity to single families of corals than to other Hexactiniæ. At all events it is advisable to keep this possibility in view in investigating corals.

I shall discuss the families in an ascending series, according to the grade of their organisation, and shall define the latter from two points of view. An Actinia is placed lower down in the scale (1) the more uniformly the parts of the body are developed, (2) the smaller the degree of histological differentiation. The first point requires us to consider how far the septa resemble one another, how far the reproductive organs are uniformly distributed, and so forth. From the second point we must keep in view the nature of the muscular system; is it preponderately ectodermal, endodermal, or mesodermal, is there a circular muscle present and to what degree is it developed? Further, I consider the presence of the acontia, the cinclides, and the "bourses marginales" as tokens of a higher organisation. Taken from this point of view, the Corallimorphidæ are the lowest in every respect, the Sagartidæ and Amphianthidæ the highest.

Family, CORALLIMORPHIDÆ, R. Hertwig.

Hexamerous Actiniæ with a double corona of tentacles, a corona of marginal principal tentacles, and a corona of intermediate accessory tentacles. Septa slightly differentiated, all furnished with reproductive organs. Muscular system weak in all parts of the body. No circular muscle.

Corallimorphus, Moseley.

Corallimorphus, Moseley, 1877, Trans. Linn. Soc., ser ii., Zool., vol. i. p. 299.

Marginal and intermediate tentacles knobbed and distinguished from one another by their size. The largest tentacles correspond to the first cycle of septa, the smallest to the last cycle of septa and to the interseptal spaces; no terminal tentacle-openings (perforations through the extremities of the tentacles, see p. 8).

The family Corallimorphidæ is at present represented only by a single genus, *Corallimorphus*, which was founded by Moseley for deep-sea Actiniæ shortly after the conclusion of the voyage of the Challenger, and divided into two species, *Corallimorphus rigidus* and *Corallimorphus profundus*. It was considered most closely allied to Leuckart's genus *Discosoma* (Rüppell, Reise im nordl. Africa, 1828), and characterised as follows:—"Body rigid, smooth, gelatinous, not contractile, without pores, but with an adherent base; disk circular and large; tentacles non-retractile, elongate, conical, with a rounded terminal

knob, of several sizes, disposed in regular series at the margin of the disk, and in two circlets on its surface."

Setting aside such characters in this definition as are common to many Actiniæ, and are therefore only of secondary value for differential diagnosis, the following points remain:—(1) The stiffness and slight contractility of the body, (2) the knobbed nature of the tentacles, (3) their distribution in several series. I attach special importance to the second and third characters, but the third requires to be more clearly defined, for it often happens in the Actiniæ that some of the tentacles have migrated inwards, far on to the disk, and are separated by a broad interspace from the marginal tentacles; Moseley has not taken into account a characteristic in the position of the tentacles which distinguishes the Corallimorphidæ from nearly all true Actiniæ, viz., that two tentacles, a marginal and an intermediate, communicate with the same intraseptal space. The intermediate tentacles thus acquire special value, as they have not merely been pushed by growth from the margin towards the centre, but may be considered as new formations of independent origin. They are therefore distinctly opposed to the marginal tentacles, have no homology with anything in most other Hexactiniæ, and consequently deserve the special designation of "accessory" tentacles.

In considering the tentacles we must not forget their varying size, especially as it reveals at the first glance the whole arrangement of the body of the Actinia. Of the marginal tentacles six are the largest, and are distributed at equal distances, then follow six more the next in size, which halve the interspaces between the first six, then twelve which come in the interspaces between the first six and the second six, and so on. This also holds good for the intermediate accessory tentacles, so that we can speak of tentacle cycles of the first, second, and third orders which completely correspond to the cycles of septa. The equalisation of the tentacles, which is elsewhere met with, has not made its appearance, and the arrangement according to cycles, which must be regarded as a primitive condition, still predominates.

An equally primitive condition is shown in the distribution of the reproductive elements over all the septa, in the indistinctness of the œsophageal grooves on the œsophagus, and in the slight differentiation of the muscular system in all parts of the body. The transverse and the longitudinal muscles form a uniform, hardly even slightly pleated layer on the septa, so that both the strong retractor and the parietobasilar muscle are still wanting; the muscular layers on the oral disk and the tentacles are smooth, and there is not the least indication of a special circular muscle. All this explains the small capacity for movement in our animal, which is, moreover, due to the nature of the supporting substance, which by its toughness reminds us of cartilage, and is richly developed in the septa, the oral disk, and the wall.

The close relationship of the Corallimorphidæ to *Discosoma*, which Moseley declared probable, undeniably exists. Verrill was the first to point out (Proceedings Elliot Soc.,

vi., Communications, p. 69) what was corroborated by Klunzinger (Korallthiere des rothen Meeres, Heft i. p. 82, 1877), that the numerous tentacles, which in *Discosoma* (Verrill and Klunzinger) and in the allied *Homactis* and *Stephanactis* (Verrill) are always united in a radial series or a group, are connected with the same radial chamber. The circular muscle seems also wanting in *Discosoma*, as the animal is not able to draw the wall over the oral disk. We might therefore incorporate the genus *Corallimorphus* with Verrill's sub-family the Discostominæ, were it not for the difference that the secondary tentacles in *Corallimorphus* are limited to a single corona, whilst in the Discostominæ they appear in larger and variable numbers. This greater regularity indicates an essentially higher grade of organisation in the Corallimorphidæ.

We must likewise bear in mind an affinity between the Corallimorphidæ and Allmann's genus *Corynactis* (Ann. Mag. Nat. Hist., ser. i., vol. xvii. p. 417), as in the latter the tentacles end in a roundish head and are partly intermediate, partly marginal. Many might also consider as points of affinity the facts that in both genera the nematocysts attain an extraordinary size, that both genera recall the skeleton-forming Zoantharia, and that the nature of the mesoderm is the same in both. The cardinal point only remains open to discussion, Are the intermediate tentacles secondary tentacles, which share the intraseptal parts with the marginal tentacles, or have they merely been forced by growth from the periphery towards the centre? This question cannot be settled by studying either the drawings or the descriptions given by Allmann, Gosse, Klunzinger, and others. Verrill also, who placed the genus *Corynactis* among the Discosomidæ, considered it as probable, but certainly not proved by actual observation that several tentacles are evaginated from each radial chamber.

Finally, it may not be superfluous to lay stress on this fact, that the double corona of tentacles does not justify us in assuming any connection between the Corallimorphidæ and the Cerianthidæ, which also have a circle of accessory tentacles in the periphery of the mouth; for what turns the scale in the definition of the grade of relationship is that the Cerianthidæ have not yet attained to the characteristic paired arrangement of the septa.

As at present there is only one genus in the whole family, it depends upon the degree of importance assigned to the special characters, whether we consider them to be characteristic of the genus merely or of the whole family. The most important undeniably are the double corona of tentacles, the equal distribution of the reproductive elements, and the absence of the circular muscle, and for this reason I have included these points in the diagnosis of the family.

Corallimorphus rigidus (Pl. II. figs. 1 and 4–6; Pl. IX. 11, 12; Pl. XII. 1–7).

Corallimorphus rigidus, Moseley, 1877, Trans. Linn. Soc., ser. ii., Zool., vol. i. p. 301.

Number of the intermediate tentacles twenty-four, of the marginal forty-eight. Origins of the septa, in the lower third of the wall and outer third of the pedal disk, shown by swollen thickenings of the supporting plate.

Habitat.—(*a*) Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Depth, 1375 fathoms. Three specimens. (*b*) Station 157. March 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E. Depth 1950 fathoms. One specimen. (*c*) Station 195. October 3, 1874. Lat. 4° 21′ S., long. 129° 7′ E. Depth, 1425 fathoms. One specimen.

Colour.—Not recognisable in *a*; blue-violet in *b* (determined from a spirit specimen); pale reddish-yellow in *c* (determined by Moseley in the fresh condition).

Dimensions.—Height, 1–2 cm.; breadth of the oral disk, 2·5–6 cm.; of the pedal disk, 1·5–6 cm.

The specimen on which Moseley founded his characteristics of the species *Corallimorphus rigidus* was not among the material handed over to me for investigation. He states that it came from a depth of 1425 fathoms, and was taken between the Banda Islands and Amboyna on October 3, 1874. On the other hand, two other bottles contained Corallimorphidæ, which answered, on the whole, to Moseley's description. The differences were merely those of colour and form, which might be easily caused by preservation and by difference of age, so that I considered it best to determine these specimens as *Corallimorphus rigidus.* I found one specimen in a bottle marked "Station 157; March 3, 1874; 1950 fathoms," which also contained a *Cereus spinosus,* and in another bottle—"Station 146; December 29, 1873; 1375 fathoms,"—there were three specimens, along with a number of other Actiniæ. The first specimen was admirably preserved, and therefore formed the principal object of my investigation. I shall deal with it exclusively in what follows, recurring at the conclusion to the variations in the three other specimens.

The body of the animal is discoid, as the pedal disk and oral disk are of equal size (6 cm.), and lie exactly parallel, whilst the height does not amount to more than 2 cm. The tentacles are deep blue-violet, the remainder of the body paler and even whitish in some parts.

The pedal disk (fig. 5) is furnished with forty-eight equally distinct radial furrows, which are limited to the outer third, and gradually become shallower as they run inwards; they do not correspond to the insertions of the septa, but to the interseptal spaces between them. The margin of the pedal disk and lower part of the wall is slightly inverted and indented, in such a way that an indentation comes in the interspace between each two radial furrows.

The points at which the septa are inserted in the wall (fig. 4) are recognisable by longitudinal furrows only half-way up the middle part; they are otherwise covered by pad-like thickenings, which are placed near the base in such a way that the furrow between each two pads occupies the middle between the insertions of two septa. Moseley also describes these pads, but gives them a different position, as he terms them "smooth, slightly projecting, rounded ridges or costæ, corresponding in position to the intervals between the attachments of the mesenteries." The conditions differ somewhat near the oral disk. Here there is a broad circular swelling, which is traversed by a number of

longitudinal furrows. All the swellings of the wall and of the pedal disk are caused by thickenings of the supporting substance.

The oral disk is smooth and very firm. Moseley has given a perfectly correct account of the manner in which the tentacles are distributed on the oral disk. The principal tentacles are placed on the margin, exactly where the oral disk and the wall meet at right angles. Among these are six tentacles, recognisable on closer observation as the largest, which are disposed at equal distances, two of them, occupying the ends of the sagittal diameter, running through the corners of the mouth. The next six tentacles stand in the middle of the interspaces between the first six, which they nearly equal in size. On the other hand, there is a noticeable difference of size between the last-named six tentacles and the twelve following, and further between these twelve and the twenty-four tentacles composing the last cycle. Whilst, therefore, there are in all forty-eight marginal tentacles, the number of the intermediate tentacles only amounts to twenty-four, which are distributed in three circles. Six tentacles, furthest in and nearest the oral opening, are placed upon the same radii with the six marginal tentacles of the first order; six others follow a little further out, and twelve others still further out, the former of which correspond to the marginal tentacles of the second, the latter to those of the third order. The first-named six are the largest, but even they are hardly so large as the smallest among the marginal tentacles.

All the tentacles are knobbed, and therefore consist of a stalk and an expanded vesicular end. The stalk is stiff and thick-walled, and bears a very thin layer of ectodermal longitudinal and endodermal circular muscular fibres. The head is thin-walled, without muscles, and not pierced by a terminal opening.

The oral opening and the œsophagus are very small. The fissure-like form, usually so distinct, is hardly recognisable, and has therefore been overlooked by Moseley. On closer examination, however, we find even here the two oral angles and œsophageal grooves, which differ very little from the numerous indentations of the oral margin and the longitudinal furrows running out from them. The corners of the mouth and of the œsophagus are more closely defined anatomically by the insertions of the directive septa.

There are altogether twenty-four pairs of septa: the first six, the principal septa, and the following six, secondary septa, are fastened to the œsophagus, even though the latter do not reach so far down as the former; the remaining twelve are imperfect. All the septa are plates of equal strength, which is essentially due to the thickness of the supporting lamella. The muscular system is extremely weak and simply arranged, as transverse fibres run on the one side and longitudinal fibres on the other in what is hardly even a slightly pleated layer. Septal stomata are wanting also in the complete septa (fig. 6).

The ovary, an oval body consisting merely of few broad transverse folds, lies in the middle of each septum, not excepting the directive septa. The excellent state of

preservation allowed of a detailed histological examination, which on the one hand confirmed the view already put forward as to the endodermal origin of the reproductive organs, and on the other threw new light on the nature of the filamental apparatus.

The youngest ovicells are placed on the margins of the ovary, especially on the lower and upper; they were unmistakably recognisable as ova from the size of 9 μ upwards, and then consisted almost entirely of the nucleus, surrounded by a thin mantle of protoplasm. They lie between the bases of the epithelial cells, distinctly still outside the supporting lamella, often united in small groups. So far *Corallimorphus* confirmed what had already been observed in *Calliactis* (*Sagartia*) *parasitica* (Actinien, p. 88); but, on the other hand, it was a new condition, that relatively large ova, measuring from 40–50 μ in longitudinal diameter, were still found in the endoderm; since they were almost as long as the epithelial cells, one end reached nearly as far as the surface. Twice I observed one of these larger cells, which was clearly in the act of migrating into the mesoderm (figs. 2 and 3). It had an amœboid, hour-glass-shaped, constricted body, of which one end lay in the epithelium, the other in the mesoderm; the nucleus was mostly in the latter, but the point of it projected into the former.

The ovicells enclosed in the mesoderm all appeared to me to have, from the first, the filamental apparatus, though in different stages of development. In the largest, almost mature ovicells (fig. 7), it is a conical body, whose base rests on the surface of the ovum. It likewise lies in the mesoderm, and its extreme point only reaches to the base of the epithelium: in this way it is distinguished from the formation of the same name in *Calliactis*, which belongs to the epithelium itself, and even projects as far as its upper surface. The distinction is of no importance, and is clearly owing to the different development of the connective tissue, which is very visible in *Corallimorphus*, whilst in *Calliactis* it is so scanty that the ovicells lie close to one another, and only a delicate supporting framework remains when they are taken away.

A second difference is of greater importance. In *Calliactis* it was not possible to distinguish nuclei in the filamental apparatus, which thus showed itself to be a differentiation of the ovum itself, whilst its cellular structure is very distinct in *Corallimorphus*. The apparatus consists of filament-shaped cells, carrying their nuclei on the base resting on the ovicell. Preparations stained with carmine showed us here a corona of oval bodies coloured red. It is possible that, in spite of all trouble taken, I did not succeed in finding out the nuclei in *Calliactis*, because I was working with osmium preparations, in which the nuclei often are difficult to colour. I might, however, have had to deal with different stages of differentiation of the structure, and this is corroborated by the following observations on the development of the apparatus in *Corallimorphus*.

Young ovicells have a single finely striated process, piercing the supporting lamella, by which they are fastened on the base of the epithelium. The epithelium is modified in a peculiar fashion at the point in question; whilst it is elsewhere overloaded with roundish

granules and shows an irregular distribution of its nuclei, its cells here become fine filaments, reminding us of sense cells, which are thickest in the middle where they bear their nucleus. They form a body which may be best compared in shape to a gustatory bulb of the mammalia; it is broad in the middle, but pointed above towards the surface of the epithelium and below towards the junction with the process of the ovum. This constitution of the filamental apparatus is rather a transition to *Calliactis;* it seems to me to indicate that the process of the ovicell only corresponds to the fibrous cord in *Calliactis,* whilst the modified epithelial cells compose a newly added constituent.

The transition into the final condition can be followed in different ovicells, step by step, through all the stages (fig. 6). Whilst the process of the ovicell is contracted, the epithelial cells penetrate the supporting substance. Their body, therefore, still lies with the nucleus in the epithelium. The nuclei gradually migrate; we first see only a few on the surface of the ovicell, later on the number increases till we have the appearance described above.

The peripheral part of the gastric cavity is divided by the twenty-four pairs of septa into twenty-four intraseptal and twenty-four interseptal spaces. Twenty-four intermediate tentacles and twenty-four marginal tentacles are connected with the former, but only twenty-four marginal tentacles, and these the smallest, with the latter. Two tentacles, an intermediate and a marginal, consequently belong to each intra-space. (Pl. II. fig. 6, shows an open intraseptal space with the two tentacles belonging to it.)

The three other specimens of *Corallimorphus rigidus* were taken at another date (29th December 1873), and in a different place, at a depth of 1375 fathoms; and as the animal observed by Moseley belonged to a third locality, it appears that these Actiniæ are very widely distributed in the great depths.

There was little indication of the natural colouring in any of the three animals, as their yellowish-brown hue was certainly referable to the change caused by the spirit. They were all distinctly smaller; one, plainly a very young specimen, was only 1 cm. high, 2·5 cm. broad at the oral disk, and 1·5 cm. at the pedal disk. It had forty-eight marginal tentacles arranged in the order already described; on the other hand, there were only twelve intermediate tentacles, the remaining twelve belonging to the third cycle being still wanting. There were eight intermediate tentacles of the third cycle in the specimen next in size, and ten in the third specimen. The last showed also most striking irregularities in the number of the marginal tentacles, of which forty-two only were observable.

The pad-like thickenings were wanting on the wall, and the insertion lines of the septa were consequently plainly indicated externally only by longitudinal furrows; in this respect the three specimens deviate from the typical *Corallimorphus rigidus* and approach *Corallimorphus profundus.* The histological character of the sup-

porting substance also varies. In *Corallimorphus* the cartilage-like consistency is caused by a homogeneous matrix, which is richly excreted, and within which traces of a fibrous tissue may still be recognised. In the specimen first described from Station 157 the fibrous mass is indistinct (Pl. IX. fig. 11); on the other hand, in the last-named three specimens (fig. 12) it is very distinct and sharply separated from the homogeneous fundamental substance, so that the latter forms a special layer contiguous to the endoderm.

Numerous small, ramified cells are scattered in the supporting lamella; some of these contained vacuoles and a single space, filled with fluid, and surrounded by a thin protoplasmic layer containing the nucleus. The vesicles of the cells were large and numerous in the first specimen, but easily overlooked in the others, as they were rarely met with and small in diameter.

The last-named diversity may be explained by admitting that the specimens are of different ages, an admission which is supported by the difference in size, and which may also explain differences in the muscular system, viz., that the ectodermal muscular layer is a smooth lamella in the three smaller specimens, whilst in the larger one it is finely folded. It is, however, advisable, under existing circumstances, to include all the four individuals under the same name.

Finally, the specimen described by Moseley had a somewhat different shape, inasmuch as the pedal disk was only half as large as the oral disk, so that the side walls of the body diverged as in an inverted cone. But as it had the longitudinal swellings on the wall described above, and the number and arrangement of the tentacles were exactly the same as in the specimen on which my description is founded, I did not consider it to the purpose to divide the material into two species.

Corallimorphus profundus, Moseley (Pl. II. figs. 2 and 3).

Corallimorphus profundus, Moseley, 1877, Trans. Linn. Soc., ser. ii., Zool., vol. i. p. 300.

Number of the intermediate tentacles limited to twelve, number of the marginal tentacles, forty-eight. Mural membrane marked by longitudinal furrows corresponding to the insertions of the septa.

Habitat.—(*a*) Station 293. November 1, 1875. Lat. 39° 4′ S., long. 105° 5′ W. Depth, 2025 fathoms. One specimen. (*b*) Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 18′ W. Depth, 1375 fathoms. One specimen.

Colour.—(Described from life by Moseley) in *b*, ochre-yellow, with dark radial madder-coloured streaks, which are wanting in *a*.

Dimensions.—Height, 0·8 and 2·5 cm.; breadth of the oral disk, 3·2 and 7·0 cm.; of the pedal disk, 1·7 and 4·5 cm.

The characteristics by which *Corallimorphus profundus* is distinguished from *Corallimorphus rigidus* are of a subordinate nature, so that I can include them in a short

description. Moreover, I had before me only the two specimens upon which Moseley has founded the species.

According to Moseley, the colour is ochre-yellow, the large specimen having darker madder-coloured radial streaks, of which traces were still visible. The base of the animal was hollowed into a cavity, and enclosed a stone to which it was attached. The insertions of the septa shone through it as white lines. The margin by which the base passes into the mural membrane is indented, the wall itself furrowed longitudinally; the number of furrows and indentations amounted to fifty. The oral disk is also furrowed, though irregularly, in a radial direction, and has the small but distinctly fissure-shaped opening in the centre.

Whilst the septa and reproductive organs show nothing new, the tentacles furnish an important characteristic by which to distinguish *Corallimorphus profundus* from *Corallimorphus rigidus*. This does not apply to the marginal principal tentacles, which are likewise present to the number of forty-eight, and are also distinguished by their different sizes, but to the intermediate accessory tentacles; these are limited to twelve, and clearly never go normally beyond this number, as one of the specimens examined was larger than the largest specimen of *Corallimorphus rigidus*. In that one of the two animals which furnished the drawing fig. 3 there was a small variation from what I have laid down as typical, which, however, may be regarded as abnormal. As Moseley observed, the number of the marginal tentacles has been increased by four, and amounts to fifty-two; instead of six secondary tentacles, halving the interspaces of the primary, there are seven secondary tentacles, one more than usual in one of the interspaces. It therefore follows that the twelve tertiary tentacles are increased by one, and the twenty-four quaternary by two, making on the whole four tentacles more. An increased growth has taken place in one of the sextants, which is shown also by the intermediate secondary tentacles; the sextant in question likewise contains two secondary tentacles of the second order, of which one, the supernumerary tentacle, is so small that Moseley has quite overlooked it.

Moseley describes the reproductive organs, of which he draws twelve, as brownish bodies showing visibly behind the thin wall. As there are twenty-four pairs of septa, all of which bear reproductive organs, the number of the latter amounts to forty-eight.

Family, ANTHEOMORPHIDÆ, Hertwig.

Hexactiniæ, with slightly developed muscular system, and long, slightly contractile tentacles, without any circular muscles (tentacles consequently non-retractile); reproductive organs present on all the septa; numerous complete septa; accessory tentacles wanting.

I have associated under the name Antheomorphidæ Actiniæ, which resemble in many

respects the following family, the Antheadæ. Like the latter they have long tentacles, of which the muscles are but slightly developed, and which are consequently capable of a small amount of contraction, and they are also unable to draw the upper margin of the wall over the oral disk. The most important difference between the two families is, that in the Antheomorphidæ incapacity for protecting the oral disk is caused by complete want of the circular muscle, whilst in the Antheadæ it is owing to the muscle being only slightly developed.

The Antheomorphidæ are easily distinguished from the Corallimorphidæ by the absence of the intermediate secondary tentacles; in other respects the grade of development is the same in both families. The principal tentacles form a single corona, which exactly occupies the point of junction of the oral disk and the mural membrane. The muscular layers of the oral disk and of the septa are hardly pleated at all. The reproductive organs are developed on all the septa.

Besides the species described two other species should perhaps be added to this family, but these were unfortunately not sufficiently well preserved to allow of detailed examination. I have therefore inscribed them on the roll of doubtful forms under the names of *Porponia elongata* and *Porponia robusta.*

Antheomorphe, n. gen.

Antheomorphidæ with a corona of tentacles placed in a single row; tentacles of different sizes decreasing according to the orders; wall smooth.

Antheomorphe elegans, n. sp. (Pl. I. fig. 8).

Twenty-four extremely long marginal tentacles of different sizes, the six largest corresponding to the six pairs of principal septa, the six middle to the six pairs of septa of the second order, the twelve last to the interseptal spaces.

Habitat.—Station 244. June 28, 1875. Lat. 35° 22′ N., long. 169° 53′ E. Depth, 2900 fathoms. Three specimens.

Dimensions.—Height, 1·5–2·0 cm.; breadth, 1·5–3·0 cm.

The three specimens upon which I founded the erection of the new genus and new species were unfortunately not well preserved, so that I had almost to desist from any examination of the inner parts, such as the septa with their muscular system. On the other hand, the general form of the body was very well preserved.

The animals had been dredged from the depth of 2900 fathoms, and were attached to stones by their extended bases. In the largest specimen the diameter of the base amounted to 3 cm., whilst the height of the cylindrical body was only 2 cm., and the diameter of the oral disk again 3 cm. The lines of origin of the septa shone distinctly through the wall as twenty-four streaks; these passed on to the oral disk, which was somewhat raised and thickened in the periphery of the mouth. In one specimen the mouth even rose like a proboscis above the upper surface of the peristome.

The twenty-four tentacles are of extraordinary length compared with the size of the animal; the largest of them are 3–5 cm. long, whilst the smallest are only 1·5–2·0 cm., the six others being of medium length. The tentacles have precisely the same arrangement as in the Corallimorphidæ, so that the largest of them correspond to the intraseptal spaces of the primary septa, the six following to the intraseptal spaces of the secondary septa, and the twelve smallest communicate with the remaining interseptal spaces in the periphery of the œsophagus.

We may therefore assuredly assume, from this distribution of the tentacles, that the septa are arranged exactly on the same principle as in the other Hexactiniæ. This is corroborated by the distinct presence of two oral angles in the mouth, and two œsophageal furrows on the œsophagus. I was, however, only able, from personal observation, to ascertain that the septa are arranged in pairs, and that all the twenty-four bore reproductive organs.

The muscular system is nowhere mesodermal, the muscular lamellæ are, moreover, nowhere thickly pleated, either in the septa or in the tentacles and oral disk. The circular muscle is consequently entirely wanting.

Family, Antheadæ, Gosse.

Hexactiniæ with long marginal tentacles and slightly developed endodermal circular muscle (so that the oral disk cannot be covered at all, or only incompletely); numerous septa, reaching for the most part up to the œsophagus, distinguished only by their size, and all (?) furnished with reproductive organs.

The family of the Antheadæ, of which the well-known *Anthea cereus* is the typical representative, was erected by Gosse. Owing, however, to my having limited it here on the basis of a more exact anatomical definition, it differs in extent from that given in Gosse's well-known work. On the one hand, I have separated from it the genus *Aiptasia*, which has acontia and cinclides, following Verrill, who was the first to declare this necessary (Comm. Essex Inst., vol. v. p. 322, 1866–7), whilst, on the other hand, I have no hesitation in incorporating in this family the Actiniæ with rough surface of the body, inasmuch as they fulfil the above-mentioned conditions, whilst Gosse considers the smooth surface of the wall as the most important characteristic.

According to my own observations, *Anthea cereus* has marginal spherules, though these do not strike the eye by their bright colours, so that we cannot separate the Antheadæ from the Actinidæ furnished with marginal spherules, on account of absence of these formations; it therefore becomes a question whether it would not be more to the purpose to follow Verrill and unite the two families (Trans. Connect. Acad., vol. i. p. 491, 1867–71). As my own experience has shown that the nature of the circular muscle in *Actinia mesembryanthemum* approaches that in *Anthea cereus*, I am inclined to answer

the question in the affirmative. In the meantime, however, we have no accurate anatomical studies of this most abundant Anthozoon.

All Antheadæ are easily recognised by their habit of body. As Verrill has already specially remarked, the first thing which strikes the eye is the numerous, extremely long tentacles, which spring from the junction of the wall and the oral disk. Their longitudinal muscles are slightly pleated, and lie in the ectoderm, as they do also in the oral disk. The circular muscle may easily be overlooked, as it is very small, and merely consists of a few folds of the circular muscular layer of the wall; hence the Antheadæ are either incapable of drawing the wall over the oral disk, or can only do so slightly, and then very slowly. The septa are very uniform, and the majority reach the œsophagus, so that only the youngest and smallest are imperfect. Whether, as I presume, they are all furnished with reproductive organs or not remains to be proved by further investigations, as I have hitherto only examined immature animals.

Comactis, Milne-Edwards.

Antheadæ with smooth body surface, with marginal spherules, which lie on a fold running outside the corona of tentacles.

Comactis flagellifera, Milne-Edwards (Pl. III. fig. 5; Pl. VI. fig. 6; Pl. VIII. fig. 9)

Actinia flagellifera, Drayton, in Dana Explor. Exped., Zooph., p. 126, pl. i. fig. 1, 1846.
Comactis flagellifera, Milne-Edwards, Hist. d. Corall., tom. i. p. 236, 1857.
Comactis flagellifera, Verrill, Comm. Essex. Inst., vol. v. p. 323, 1867.

Marginal spherules on a fold, which is separated from the tentacles by a circular depression. Tentacles moderately long, with distinct terminal opening, placed in two to three rows. Body discoid.

Habitat.—Simon's Bay, Cape of Good Hope. Depth, 25 fathoms. One specimen.

Dimensions.—Height, 0·5 cm.; breadth, 1·5–2·0 cm.

The small Actinia, which I define with some reserve as *Comactis flagellifera*, came from Simon's Bay, Cape of Good Hope, where it was dredged at the insignificant depth of 25 fathoms. As no trace of reproductive organs could be found even on minute investigation, it was, at all events, an immature animal, so that the above assertion as to size cannot be considered as the standard for characterising the species.

The wall is smooth, for although the surface in the specimen before me was repeatedly wrinkled, both transversely and longitudinally, this was plainly owing merely to the high degree of contraction of the animal. There are, moreover, two very distinct circular constrictions, a lower one caused by the action of the parietobasilar muscle, which divides the body into two equal parts, and an upper one lying close under the tentacles, and caused by the circular muscle which runs there. Outside the latter the wall-

membrane forms a circular fold, with numerous small evaginations on its edge. These correspond to the intraseptal and interseptal spaces, and must be compared to the marginal spherules, which are found in the same situation in *Actinia mesembryanthemum*, and are conspicuous by their splendid colour; they are, however, not so richly furnished as in the above-named Actinia with the strongly refractive nematocysts, which Rötteken, Schneider, and Duncan (Proc. Roy. Soc., London, vol. xxii. p. 263) held to be retinal rods, and were thus led to regard the marginal spherules as eyes.

The circular muscle (Pl. VI. fig. 6) is not visible to the naked eye, as it is very weak, and may be easily overlooked even under the microscope. The endodermal circular muscular layer is only folded a little more thickly than at other points, and shows three to four larger and a few smaller dendritic figures in transverse section. The folded muscular lamellæ, which are supported by relatively strong connective substance, project towards the gastric space, and are not enclosed in the connective substance of the wall, and in this way an insignificant circular swelling is formed. The nature of the circular muscle as described above furnishes a further point of comparison with *Anthea cereus*, in which the organ is only slightly stronger.

The tentacles are over a hundred in number, and lie in three circles close to the peripheral margin of the oral disk; the largest of them, belonging to the innermost circle, are only 0·5 cm. long; they are all thick-walled, and as thick at the rounded end as at the base. They are pierced by a small terminal opening, which is usually perceptible to the naked eye, especially in tentacles from which the epithelium has been stripped off.

The longitudinal muscles in the ectoderm, which pass on to the oral disk as radial fibres, recall in many respects the ectodermal muscular fibres in the wall of *Cerianthus;* they are borne by very thin supporting lamellæ, which are slightly branched and lie close together, though they never attain the same extraordinary length as in *Cerianthus* (Pl. VIII. fig. 9). Here and there we find isolated mesodermal bundles of muscles, whose fibres correspond in their extreme fineness to the longitudinal ectodermal muscles. As the wide œsophagus protrudes outwards the numerous longitudinal streaks on it are almost obliterated. The œsophageal grooves are also somewhat indistinct, as the tube is folded irregularly here and there. There is no reason, however, to question their existence, as I observed the directive septa in transverse sections.

All the septa appeared to be perfect, though the youngest did not reach far down the œsophagus. I could not settle their number accurately: the portion which I cut off, and which I took to be about one-fourth of the entire animal, contained six pairs of two different sizes, the smaller alternating regularly with the larger. This would give forty-eight septa for the whole animal, which are distributed in three cycles, taking for granted that this Actinia follows the hexamerous type. This view is so far warranted by the undeniable approximation of *Comactis flagellifera* to the hexamerous *Anthea cereus*.

I must finally justify my determination of the animal as *Comactis flagellifera.* The much shrunken specimen before me had at first sight but little resemblance to the first and only drawing of *Comactis flagellifera*, given by Dana in the account of his voyage, the contrast being especially marked in the shortness of the tentacles, which Dana has drawn and described as very long. This, however, becomes of less importance if we consider that we have before us a young specimen preserved in spirits. Verrill, who was able to examine spirit specimens of this species, also lays stress on the fact that their very numerous tentacles, which are of nearly equal length and placed closely together, are contracted into a compact, conical form, that they then measure only 0·25 of an inch in length, and have a very distinct terminal opening. The last characteristic becomes more important, from the circumstance that I have never met with any other Actinia in which the existence of the terminal openings could be recognised with the naked eye. (Those forms, of course, being naturally excepted in which the tentacular apparatus has undergone retrograde metamorphosis.)

Verrill's description continues thus : " The column is very short, with a fold below the margin and separated from it by a " fosse." On the outer edge of the fold the tubercles form a simple row. They are prominent, smooth, round, and nearly equal.' All this applies equally to the Actinia examined by me.

Family, Tealidæ, Hertwig.

Hexactiniæ with numerous perfect septa, and very contractile, moderately long or short tentacles, which can be completely covered. Circular muscle very strong, endodermal, projecting as a thick swelling into the gastric cavity.

The systematic descriptions of former naturalists, such as Gosse, Verrill, Klunzinger, &c., included the *Tealiæ* along with the species of *Bunodes*, as " *actinines verruqueuses* " in the family of Bunodidæ, which I do not consider a happy combination. In the course of this memoir I shall have occasion to describe an Actinia, which must be placed in the genus *Bunodes*, if we keep the definition given by Gosse and others, but whose structure approaches that of *Sagartia* more closely than that of *Tealia*. If it be assumed that this single species, the only one examined in detail till now, may be taken as the paradigm for the other forms of the genus *Bunodes*, there can be no doubt that the genera *Bunodes* and *Tealia* must be widely separated systematically.

Having the possibility just mentioned in view, I considered it to the purpose to introduce the family name Tealidæ, and I took the structure of *Tealia crassicornis* as the paradigm for its definition. Two other Actiniæ, *Tealia bunodiformis* and *Leiotealia nymphæa*, of which I am about to give a detailed description, are allied to this widespread form, which, however, was not represented in the Challenger material.

The most important feature of the family is, I consider, the extremely characteristic

circular muscle, which can be recognised with the naked eye, as a thick swelling on the inner side of the wall. In transverse section it shows a circular or oval figure, fastened on one side to the wall; it is formed by extremely strong pleating of the endodermal circular muscular layer.

The large number of perfect septa is also of importance; on the other hand, I have entirely disregarded the nature of the surface of the body, so that forms both with smooth and with warty wall may find their place in the family.

Tealia, Gosse.

Wall covered with numerous, irregularly scattered warts; body broader than high, tentacles numerous, retractile, all of equal size.

Tealia bunodiformis, n. sp. (Pl. VI. fig. 4, Pl. VIII. figs. 3–5).

Warts very numerous, small, densely crowded together, with a tendency to arrangement in longitudinal rows. Surface of the body encrusted with foreign substances.

Habitat.—Shore of Tristan da Cunha. October 15, 1873. Three specimens.

Dimensions.—Breadth, 1·5–2·0 cm.; height, 1·0 cm.

Three small forms, collected as shore inhabitants on the coast of Tristan da Cunha, belonged to this Actinia, which, in consequence of the strong contraction of the body and the influence of the alcohol, had lost in great measure the marked characteristics of its external habit of body. They had been partially injured by being detached, and were otherwise so much contracted, that the oral disk and tentacles were covered by the margin of the mural membrane, and the body formed a shapeless mass, from 1·5–2 cm. in diameter.

The wall is encrusted in some parts with sand granules and covered with numerous papillæ, which are simply small elevations of the supporting substance covered with the usual epithelium. As they are of unequal size and irregularly and thickly distributed over the surface, the animals must be referred to the genus *Tealia* (Gosse). The constitution of the circular muscle, which is intermediate between that of *Tealia crassicornis* and of *Leiotealia nymphæa*, also favours this view.

The circular muscle (Pl. VI. fig. 4) is chiefly endodermal, and projects into the gastric cavity as a thick swelling on the upper margin of the wall. It shows an oval figure in transverse section. The margin of the muscle, where it is attached to the wall by a very narrow base, is pierced by a cord of connective substance, which soon divides into two smaller cords only running a little way. The supporting lamellæ covered with muscular fibrillæ run out from the latter; they are extremely long in the middle of the swelling and only slightly ramified, whilst they are shorter towards the sides, and form numerous lateral branches.

The trunk, from which these ramifications proceed, being divided into two main branches, two systems of supporting lamellæ are present, radiating respectively one from each of these; the two systems are contiguous in the median plane of the muscle, thus giving rise to repeated fusion of their respective supporting plates. The muscular layers become consequently detached into bundles of muscles, and the endodermal muscles partially transformed into mesodermal. The pleatings of the same system rarely become connected with one another by lateral lamellæ, though this is more frequent at the point where the circular muscle passes transversely through a septum; indeed here they are often connected to such an extent that a great part of the muscular fibrillæ runs for some time entirely in the mesoderm.

In the upper half of the wall we find small endodermal evaginations, which grow like glands into the underlying connective substance (Pl. VIII. fig. 4), and show a streak of blackish colouring in transverse section. Their cæcal end nearly reaches the ectodermal epithelium, but is always separated from it by a thin partition of connective substance, so that we never find small openings comparable to cinclides. The colouring is caused by the accumulation of black pigment granules in the endodermal epithelium. The endodermal muscular layer is not so thickly pleated throughout the region of evagination as in other parts of the wall. The evaginations seemed to me to be present only in the intraseptal spaces, but they were so frequent there that many intraseptal spaces showed three of them in radial section.

The oral disk and tentacles did not admit of detailed examination; enough that both parts possess an ectodermal, richly-pleated muscular lamella. The septa, on the contrary, are of special interest, firstly, from the constitution of the muscular system, and, secondly, from their arrangement (Pl. VIII. figs. 3 and 5).

The longitudinal muscles of the septa are developed to an extent which I have never met with in any other Actinia; they form thick swellings, showing an extremely delicate figure in transverse section. The pleatings of the supporting substance, which are covered with muscular fibres, are thickly branched, lie closely together, and pass one between the other in such a way as to form in transverse section what one might almost call a "meandrous complication," although the supporting layers never absolutely become fused. The mass of the muscle actually projects above the surface of the septum, and presents a mushroom-shaped appearance, caused by the constriction at its base.

The muscular swellings lie on the septa till within a short distance from the wall and from the oesophagus; there the muscular fibrillæ extend in a smooth layer, and only become again more closely pleated when still nearer the wall. A slight parietobasilar muscle on the side of the transverse muscular layer corresponds to this second longitudinal cord.

All the septa are grouped in pairs in such a way that, with the exception of the two

pairs of directive septa, the faces provided with longitudinal muscles are turned to one another. The directive septa on both sides (fig. 5, *rh*) are formed very irregularly; in each pair one septum is very strong, whilst the other is rudimentary; the latter never reaches as far as the œsophagus, and was so small in one case that it was not possible to perceive the manner in which the muscles were arranged.

The other pairs of septa vary in size, though they could not be divided into different orders, as a series of strong, large septa, which have almost all attained to an equal degree of development, is followed by a number of smaller septa; the former reach to the œsophagus, whilst the latter are imperfect. There were, on the whole, probably from thirty to forty pairs of septa. This difference of size in the septa, and especially the disproportion between the directive septa, is so unusual that it comes to be a question whether the specimen examined was normally developed.

Tealia bunodiformis belongs to those species in which I have observed that two adjacent septa may be connected by their free margins. In such cases it is two septa of different adjacent pairs which pass continuously into one another inside the strong longitudinal swellings.

The reproductive organs of the animal examined were ovaries, and were found on all the septa, except on those which were behindhand in their development. Two of the directive septa were consequently sterile, whilst the other two were furnished with reproductive organs.

Tealia bunodiformis differs very markedly from *Tealia crassicornis*. In *Tealia bunodiformis* the muscular fibres of the tentacles and oral disk are ectodermal, whilst in *Tealia crassicornis* they have passed into the mesoderm; in the former, reproductive organs are present on the septa of the first and second order, whilst in the latter they are absent. It may, therefore, perhaps be well at some future time to make *Tealia bunodiformis* represent a new genus distinct from *Tealia crassicornis*. I have chosen the name "*bunodiformis*," because in some parts the warts are grouped in longitudinal rows, and therefore have the same arrangement which characterises the genus *Bunodes*.

Leiotealia, Hertwig.

Tealidæ with smooth body surface, without warts, and without spherules, but with longitudinal furrows corresponding to the insertions of the septa; tentacles of equal size, arranged in several rows.

Leiotealia, as the name shows, is a *Tealia* with smooth body surface, and therefore bears the same relation to the true *Tealia* as *Paractis* does to *Tealidium*. According to Milne-Edwards they belong to the genus *Paractis*, from which I have separated them on account of the endodermal position of the circular muscle.

Leiotealia nymphæa (Pl. VII. figs. 1–5).

Actinia nymphæa, Drayton, in Dana. Expl. Exp., Zooph., p. 146, pl. iv. fig. 33 (Synopsis, p. 10), 1846.

Paractis (?) *nymphæa*, Milne-Edwards, Hist. des Corall., tom. i. p. 252, 1857.

Sagartia (?) *nymphæa*, Verrill, Trans. Connect. Acad., vol. i. p. 486, 1871.

Tentacles short, in three rows, body constricted half-way up by a special circular muscle, insertions of the septa shining through the wall as longitudinal lines.

Habitat.—Station 149. Christmas Harbour, Kerguelen. January 29, 1874. Depth, 120 fathoms. One specimen.

Dimensions.—Height, 1 cm.; breadth of the base, 2 cm.

This small Actinia, of which there was only a single specimen, was examined in a strongly contracted condition. The oral disk was completely inverted, and the margin of the peristome drawn over it, so that only a narrow passage was left; at two-thirds of the height the body showed a circular constriction, caused, as we shall see, by a special muscle, which is wanting in most Actiniæ.

The surface of the body in *Leiotealia nymphæa* is perfectly smooth, and so thin that the origins of the septa, which number more than a hundred, shine distinctly through it, in the form of white lines. Muscular fibres are present only on the endodermal side, and form a smooth layer, which, from the contraction of the animal, was only slightly pleated, though it was thickened at two places into distinct sphincters. The upper sphincter is the more powerful, and corresponds to the sphincters of other Actiniæ in its position, immediately under the margin of the peristome, and in its action, for like them it draws the wall together like a bag; it is a circumscribed muscle, and projects into the stomach as a circular swelling, which is only fastened to the wall by a narrow base, and pierces the origins of the septa. Seen in transverse section (Pl. VII. figs. 2 and 4) a process of the supporting lamella of the wall makes its way into the inside of the swelling, and traverses it nearly to the opposite end; it thus divides the swelling into two parts, the upper being about three times as broad as the lower, which pass into one another at the free end of the process. Unless the section passes through the precise point where the sphincter pierces the septum, each part shows on the surface a layer of epithelium, and inside the repeatedly folded muscular lamella, supported by very fine folds of connective tissue. The folds of connective tissue spring from the axis of connective tissue, and throw out irregularly several lateral branches, all equally covered with muscular fibrillæ. The spaces between the folds of connective tissue are open towards the epithelium, so that the latter passes in between them. The lower ends of the pleatings of the muscle are rarely detached, so as to form flat mesodermal bundles of fibrillæ; this takes place more frequently at the free end of the axis of connective tissue.

The lower circular muscle (figs. 2 and 5, *ms'*) is less highly developed; to the naked eye it shows as a narrow palish-yellow tract, running upwards and downwards; seen

under the microscope, it consists of a muscular lamella pleated into unbranched folds, which lie closely together like the leaves of a book, are highest in the middle of the tract, and gradually decrease in size on either side till they pass into the smooth fibrillar layer of the wall.

The constitution of the oral disk of the specimen examined could not accurately be determined, as it was closely folded in consequence of the extreme contraction. Its peripheral margin bore three alternating rows of tiny tentacles, which only projected like small buttons, and corresponded in number to the individual septa. On transverse section, the tentacles of the inner circle proved to be evaginations of the intraseptal, whilst those of the outer circles belonged to the interseptal spaces.

The radial muscular fibres of the oral disk (Pl. VII. fig. 1) are mesodermal, but otherwise only slightly developed. Sparse thin bundles are separated from the ectoderm by a narrow layer of connective substance, and connected like a net with one another by an interchange of fibres. They enter the bases of the tentacles and extend to their points. There were apparently no openings in the tentacles.

The pedal disk is of no great interest. A small circular ridge, caused by a thickening of the supporting lamella, ran on its inner side between the septa, at a little distance from and parallel to the margin. As I only examined a single specimen of this Actinia, it is impossible to determine whether this structure is constant or not.

The species before us is chiefly characterised by the size and disposition of the septa, of which I therefore give a more detailed description. It is difficult, on the whole, to recognise in their arrangement the regularity shown by the Hexactiniæ. The six pairs of principal septa, of which two lie as directive septa in the sagittal axis, are certainly distinguished at once by their size, but the six pairs of the second order are very small, and in this respect fall short of the twelve pairs of the third order. All the septa already mentioned reach to the œsophagus, whilst those following are imperfect. Of these the twenty-four pairs of septa of the fourth order are always present, but unequally developed, being larger in the neighbourhood of the principal septa, smaller in the neighbourhood of the septa of the second order. This latter region is, therefore, plainly retarded in growth, and this becomes still more conspicuous in the following septa. In the interseptal spaces, which are contiguous to the septa of the second order, the septa of the fifth order are extremely small, and those of the sixth order are still completely wanting. On the other hand, in the neighbourhood of the principal septa, the septa of the sixth order are already as large as those of the fifth order. It is, however, quite possible that the irregularities just described become equalised in the course of growth, as the specimen examined was a young animal without any indication at all of reproductive organs.

The muscles of the septa show peculiar conditions, especially the longitudinal and parietobasilar muscles. The former is only distinctly present on the septa of the first

three orders, and except in the directive septa projects into the intraseptal space; it is a powerful muscular protuberance, which begins at nearly equal distances from the middle point and the periphery of the pedal disk, becomes distended half-way up, and then gradually becomes narrower till it is inserted at the oral disk inside the tentacles (Pl. VII. fig. 5). The muscular protuberance lies almost freely on the surface of the septum, and is only fastened to it near its adaxial margin by a kind of mesentery. In transverse section, it therefore shows (fig. 3) a figure resembling a mushroom-shaped excrescence, a broad mass from which a stalk thrust to one side passes up to the septum. The connective substance of the septum enters through the stalk into the longitudinal muscle, where, seen in transverse section, it becomes dendritically branched. The ramified lamellæ of connective tissue, which produce the dendritic figure in transverse section, are covered by a continuous layer of muscular fibrillæ; the whole is covered with epithelium, which reaches to the bottom of the interstices between the layers of connective tissue, so that the endodermal muscular fibres never become transformed into mesodermal fibres.

The longitudinal muscle described above is part of the layer of longitudinal fibres, which is slightly folded in other places, and shows in transverse section a second smaller dendritic figure at the base of the septum only. Opposite it, on the other side of the septum, we reach the site of the transverse muscular fibres, which are directed transversely from the wall towards the axis of the body of the Actinia, and as usual are strongest in the upper third. The parietobasilar muscle is found on the same side, where it can be distinctly recognised as originating by a pleating of the transverse muscular layer. It is, in fact, simply a crescentic fold lying loosely on the septum, so that a pouch-shaped space opening into the stomach, into which one can thrust the point of a needle, always runs in between the two parts. The fold is covered on both sides with an ample muscular layer running parallel to the margin of the fold. The parietobasilar muscle springs from the pedal disk, from its margin nearly to its middle, after which it is attached to the wall as far up as the lower circular muscle. When the animal is contracted it draws the pedal disk and the wall nearer one another, and as the former is the part which is more easily moved, it becomes arched upwards, and so forms a slightly depressed sucker; the muscle therefore plays an important part in attaching the body of the Actinia to the ground beneath. As regards septal stomata, the inner or peristomial appear to be present, whilst the outer or marginal are certainly wanting.

I consider the small Actinia described above as identical with a small form found by Dana, near Valparaiso, in the American expedition under Captain Wilkes. According to Dana's description, the whole animal is whitish, with a touch of yellowish-brown, the oral disk pale flesh-colour, and the tentacles yellow. Drayton gave it the name of *Actinia nymphæa*, which was afterwards changed by Milne-Edwards into *Paractis nymphæa*; finally, Verrill included the species with a mark of interrogation in the genus *Sagartia*, for which, however, there is no sufficient ground.

Family, PARACTIDÆ, Hertwig.

Hexactiniæ, with numerous perfect septa, and with very contractile, moderately long tentacles, which can be completely covered ; circular muscle very strong, mesodermal.

The Paractidæ form a family parallel to the Tealidæ; they agree with the latter in the nature of the septa and the tentacles, but differ from them in the nature of the circular muscle. The latter is enclosed in the mesoderm, and either lies close under the endoderm or is forcibly separated from the epithelium by the secretion of abundant connective tissue. In this family, as in the Tealidæ, I include not merely the animals with smooth body (genera *Paractis* and *Dysactis*), but also the papillose forms of the genera *Tealidium* and *Antholoba*.

Paractis, Milne-Edwards.

Paractidæ with smooth body surface, without papillæ and without marginal spherules ; tentacles nearly equal in length and in strength ; numerous longitudinal furrows of the wall.

The genus *Paractis* was founded by Milne-Edwards for Actiniæ, of which the wall has neither papillæ nor marginal spherules, but can be drawn completely over the oral disk and tentacles ; the tentacles are said, moreover, to be nearly equal in length.

Two forms of the Challenger material fulfilled these requirements ; they differed, however, in one very important point, as the circular muscle was endodermal in the one, mesodermal in the other. The former consequently belongs to the family of the Tealidæ, and for it I have composed the new name *Leiotealia*, whilst for the latter I have retained the name *Paractis*.

Paractis excavata, n. sp. (Pl. I. fig. 6, Pl. XI. figs 13, 14).

Wall with more than fifty longitudinal furrows, corresponding to the septa, oral disk hollowed like a dish, with two rows of tentacles, the outer somewhat larger than the inner ; tentacles thick walled, with strong mesodermal muscles, which are present only on the adaxial side at the base, but surround the tentacles on all sides towards the point.

Habitat.—Station 300. December 17, 1875. Lat. 33° 42′ S., long 78° 18′ W. Depth, 1375 fathoms. One specimen.

Dimensions.—Diameter of the pedal disk, 2·5 cm., of the extended oral disk, 6 cm. Height of the wall in the contracted animal 2·5 cm., from the pedal disk to the margin of the mouth 1 cm.

Paractis excavata, which I describe as a new species, founded by me upon a single specimen, is one of the most characteristic forms of the Challenger material, both as to the shape of the body, and as to its finer structure.

In the strongly contracted condition, shown by the specimen, the body appears to be as high as broad, and also of equal breadth in the region of the pedal and of the oral disks. On dissecting the animal, however, it becomes evident that if the height of the animal is to be determined by the distance of the oral margin, from the pedal disk, it will fall far short of the breadth, and, moreover, that the diameter of the contracted oral disk is considerably greater than that of the pedal disk, which it must have exceeded twice at least. When fully extended, our Actinia must have been shaped like a dish, the wall diverging from the narrow base towards the broad oral disk.

The wall rises from the margin of the moderately firm pedal disk, which measures about 2·5 cm. in diameter, and is irregularly wrinkled and furrowed, to a height of about 3·0 cm.; it is covered with fifty-four longitudinal furrows, which are separated from one another by equal intervals, and reach from the lower to the upper margin of the wall. These longitudinal furrows are crossed in the lower part of the wall, by irregular transverse furrows, which become more indistinct towards the upper part. The wrinkled and knobby appearance of the lower part of the wall thus produced I consider to be the consequence of the high grade of contraction of the animal.

The wall is firm like leather, but of no great thickness; only that portion of it contiguous to the oral disk is distended about 0·5 cm. by the contained mesodermal circular muscle. The bundles of the latter are small, and composed merely of a few fibrillæ; they run irregularly, either singly or united in groups in the fibrous connective substance. They are separated from the ectoderm by a broad interspace, but extend nearly to the circular muscular layer of the endoderm, and are even connected with it in some parts, so that steady growth of the circular muscle undeniably takes place by the transformation of endodermal elements into mesodermal. The principal mass of the circular muscle still extends downwards a little way, in a layer of mesodermal bundles of fibres, lying close under the endoderm.

The oral disk bears fifty marginal tentacles, and is covered with an equal number of radial furrows, which begin at the oral margin and end between each two tentacles. The radial swellings lying between the furrows are flattest near the mouth, and become more distinct in proportion as we approach the tentacles. This proceeds from the distribution of the muscles, which are very weak near the oral margin, and become stronger towards the periphery till they swell out into the powerful muscular masses of the tentacles. The muscular fibrillæ are remarkably strong, partly perhaps in consequence of having swollen from the unsatisfactory state of preservation. Their principal mass lies united in thick bundles in the mesoderm; where the muscular system is weak the bundles are scanty, and the separating tracts of connective tissue broad, whilst towards the corona of tentacles the bundles lie close to one another, and the fundamental substance becomes a slender framework. As muscular fibres still remain in the ectoderm the oral disk, if well preserved, would furnish an admirable subject for studying

the different stages by which the ectodermal muscles are transformed into mesodermal. As far as I could observe the supporting substance rises on the surface of the disk in numerous folds covered with muscular fibrillæ.

The tentacles are placed in two alternating rows, those of the inner row being rather shorter and weaker than those of the outer row, whose length in a contracted condition was 1·0–1·3 cm. They are thick-walled at the base, and run out into a fine point, without any terminal opening. They are all strongly bent inwards, and have a hook-like shape, which is caused by the distribution of the muscles. In most Actiniæ, as we know, the muscles surround the tentacles uniformly, but in *Paractis excavata* they are crowded together towards the adaxial side where they form a muscular pad, which I have never found equalled in strength in any other Actinia. In the tranverse sections (Pl. XI. fig. 14) the muscular fibrillæ lie close together, and the framework of connective tissue is completely hidden, and only becomes distinct by appropriate staining; it forms a network whose meshes are small near the supporting lamella, but large and longish towards the epithelium, enclosing spaces lying perpendicular to the surface of the tentacle. The surface of the tentacles was not well preserved, so that I could not determine whether these spaces were completely closed, or whether they communicate here and there with the epithelium, which appears to me more probable.

Over one half the circumference of the tentacle the muscular layer is of uniform thickness, but thins out over the remaining half into a delicate membrane, which seemed to me to be wanting at the base of the tentacle, unless perhaps it had been rubbed off. In spite of the varying strength of muscular layer, the thickness of the tentacle wall is essentially the same all through in transverse section, as the connective tissue substance becomes thinner in proportion as the muscular layer becomes thicker.

It is, however, only the lower third of the tentacle which comports itself in the manner above described, a transverse section through the point presents an essentially different figure. The muscular layer is weaker indeed but present on all sides, it merely becomes a little smaller for a short space on the abaxial side than on other parts of the transverse section. A series of transverse sections rising from the base to the point shows all the transitions between the two extremes, and we can follow step by step the process by which the muscular layer, which originally lies only on one side of the tentacle, gradually surrounds it entirely. I have only figured three transverse sections of such a series, of which one is taken at the base (fig. 13, *c*), the second (fig. 13, *b*) from the middle, and the third (fig. 13, *a*) from the point. In all of these the thickness of the muscular layer is indicated by hatching.

The œsophagus is very short, corresponding to the height of the animal; it is furnished with two œsophageal grooves, and eighteen longitudinal swellings. Six pairs of septa of the first order, and six pairs of the second order, are inserted in the œsophagus,

besides which there are twelve pairs of imperfect septa of the third order. Septal stomata are wanting throughout. The parietobasilar muscle reaches to about one-fourth of the height of the wall, where it gives rise to a circular constriction.

All the septa bore reproductive organs. As the animal examined was a female, I was able to prove the existence of the filamental apparatus, which most resembles that of *Calliactis parasitica.* A conical process rises on the surface of the ovum, the point of which pierces the supporting lamella, and reaches to the free surface of the epithelium. The specimen was, unfortunately, not sufficiently well preserved to determine whether the process is formed of special cells, or is part of the ovicell itself.

Paractis excavata is perhaps allied to the *Actinia peruviana* of Lesson (Voyage de la Coquille, Zoologie, tom. ii. part ii., 2, p. 75 ; Zoophytes, pl. ii. fig. 3) ; the number, form, and arrangement of the tentacles, and the expansion of the body at the upper end is common to both. The longitudinal furrows on the outside of the wall, which are so distinct in *Paractis excavata,* are however wanting in the *Actinia* (*Paractis*) *peruviana;* there are said to be merely " quelques plissures brunâtres " present on the lowest section of the wall.

Dysactis, Milne-Edwards.

Paractidæ with smooth body surface, without papillæ, and without marginal spherules ; tentacles very unequal in size, the inner essentially larger than the outer, completely retractile.

I have kept essentially to the definition of the genus *Dysactis,* as given by Milne-Edwards ; differing from him only in one subordinate point, for while he limits the number of the rows of tentacles unnecessarily to two, I make no definite assertion on this point. I differ more decidedly from Verrill (Mem. Boston Soc., vol. i. p. 26, 1866-69), who has placed the genus *Dysactis* among the Antheadæ, and consequently makes it the most important character of the genus, that the wall cannot be drawn over the oral disk and tentacles. I do not understand why Verrill should differ in opinion from Milne-Edwards, who has placed the genus *Dysactis* among the forms with retractile tentacles.

Dysactis crassicornis, n. sp. (Pl. VII. figs. 6–12).

Height of the body rather greater than the breadth ; tentacles short, thick-walled and conical, arranged in four to five rows, and decreasing in size from within outwards, 24 tentacles in the first row, 24 in the second, 48 in the third, &c.

Habitat—(*a*) Station 312. January 13, 1876. Lat. 53° 38′ S., long. 70° 56′ W. Depth, 10 to 15 fathoms. One specimen. (*b*) Station 313. January 20, 1876. Lat. 52° 20′ S. long., 68° 0′ W. Depth, 55 fathoms. Four specimens.

Dimensions.—Height, 4–7 cm. ; diameter of the pedal disk, 3–7 cm.

I made *Dysactis crassicornis* the subject of detailed examination, as there were

several points about it which seemed to indicate it as a suitable object for such a purpose. In the first place the unusual size of the body is favourable to dissection by means of knives and scissors, and in the second place, it was represented in the Challenger material by a large number of tolerably well preserved specimens. Two of the individuals were in a state of intense contraction, whilst in the other three the tentacles still projected through the opening formed by the upper margin of the half-contracted wall.

The pedal disk is moderately thick, irregularly warted on the surface, otherwise flat. It passes at right angles into the wall, of which the surface is perfectly smooth, except in the upper part, which is folded longitudinally in consequence of the contraction of the circular muscle. Most of the animals are distended like a drum, as sometimes happens in the Actiniæ, so that the wall has become a thin membrane with the origins of the septa shining through it. At its upper margin only, where it is connected with the oral disk, the wall becomes thickened to from four to five times its usual strength (fig. 12), and shows in transverse section a yellowish tract, lying in whitish fundamental tissue close under the endoderm, which is caused by the circular muscle running in this part.

The bundles of fibrillæ appear in transverse section (Pl. VII. fig. 7) as roundish or repeatedly indented figures, whose periphery consists of a corona of fine fibres, but whose centre appears in the spirit material almost empty, whilst in the living animal it is filled with protoplasm and the nuclei of the muscular corpuscles. The bundles of fibrillæ lie so closely together in the fibrous fundamental tissue of the mesoderm that it is hardly possible to determine distinctly whether or not they are united into smaller and larger groups. As the section shows, they become divided and united by anastomoses into an annular plexus, lying parallel to the course of the fibrillæ, *i.e.*, parallel to the pedal disk (fig. 9).

Different points in the distribution of the bundles of fibrillæ favour the view that the mesodermal bundles originate in the endoderm, and only become deposited secondarily by detachment in the mesoderm, where they increase still more by division and separation. The bundles of fibrillæ lie usually in layers parallel to the endodermal surface, as a few more compact layers of supporting substance extend through the mass of the bundles parallel to the endoderm. The largest bundles are placed nearer the ectoderm, where they are separated from one another by broader layers of connective substance, whilst the smallest bundles (fig. 8) lie close under the endoderm, and—what is the most important point—are connected here and there with the circular layer of fibres which run on the endodermal surface of the mesoderm.

The oral disk is covered with numerous shallow furrows, running from the oral margin towards the tentacles. Their radial muscles form a tolerably broad stratum in the mesoderm, and this is separated from the ectoderm by a thin, and from the endoderm by a thick, layer of connective substance (Pl. VII. figs. 10 and 11). This stratum is again com-

posed of bundles of fibrillæ, which are chiefly flattened in a lateral direction, so that the stratum seems to consist merely of apposed bands of muscles. As each band is repeatedly indented laterally, and can be dissected into separate pieces lying one below the other, they give rise to the very complicated formation shown in fig. 10, which is specially striking from the close apposition of the bundles of fibrillæ.

The bundles of fibrillæ are more scattered in the younger animals; smaller bundles of fibrillæ are also found here lying towards the ectoderm in the intermediate layer of connective tissue. It is quite conceivable that these smaller bundles may have migrated from the ectoderm into the mesoderm, in order to supplement the mesodermal muscular layer. The state of preservation of the material did not allow me to confirm this supposition, as I could not make out whether or not radial muscular fibres were persistent in the ectoderm. In the peripheral part of the oral disk the bundles of fibrillæ pass into the tentacles, where they preserve exactly the same arrangement and position in the mesoderm.

The corona of tentacles is immediately contiguous to the wall, whilst in *Tealia crassicornis*, which in other respects is not unlike *Dysactis* in its general habit of body, it is separated from the wall by a portion of the oral disk capable of becoming pleated. The corona consists of several hundred tentacles, which are distributed in four to five rows, and decrease distinctly in size from within outwards. If we examine an animal which is developed uniformly in all sextants, we find twenty-four tentacles in the first or innermost row, and twenty-four tentacles also in the second row, which alternate with the preceding twenty-four. In the third row the number rises at once to forty-eight, which are placed in such a way that they alternate both with the twenty-four tentacles of the first row, and the twenty-four of the second row. In the fourth row the number is again doubled, so that it consists altogether of ninety-six tentacles, which still alternate with all the preceding tentacles. The last row is always irregularly developed; the number of tentacles ought to amount to 192, but only came to some 90.

It will be seen at once from this mode of arrangement that all the tentacles of *Dysactis*—and this applies to almost all Actiniæ—lie in different radii, and must therefore belong to different radial chambers; they are merely parts of a single circle which have become distributed in different rows, from being displaced in the course of growth. It follows necessarily, from the whole mode of arrangement, that the separate rows of tentacles stand in regular relation to the radial chambers, as the same principle of arrangement, viz., that each cycle contains the same number of units as all the preceding taken together, applies to both. From my own observation in making preparations, I am convinced that the twenty-four tentacles of the first series belong to the twenty-four intraseptal spaces of the septa of the first to the third orders, the next twenty-four tentacles to the twenty-four intraseptal spaces of the fourth order, and so on.

Exceptions occur to the conditions which I have laid down as regular, but these can

be easily explained by the fact that growth is not equally rapid in different sextants, or even in the separate parts of the same sextant. For example, in one sextant of a *Dysactis*, in which the first circle consisted of only eighteen tentacles, I found that the tentacles really corresponding to the septa of the third order were still in the second row, and that all the following tentacles were correspondingly a row in arrears; the first row in the said sextant only contained two tentacles instead of four.

Terminal openings are wanting in all the tentacles. In consequence of the strongly developed mesodermal muscles they are unusually thick-walled, on account of which I have named the species "*crassicornis*." The largest of them, the tentacles of the first row, are not 1 cm. long in a contracted condition, whilst they spring from a base of considerable size whose diameter in a radial direction nearly equals the height of the tentacle. The tentacles have therefore the form of short cones, flattened in a tangential direction; seen from the side of the radial chambers they extend like wide-mouthed pouches, running to a point.

The tentacles lying towards the outside not only become smaller but, above all, narrower at the base, and consequently more slender. The outermost tentacles are so small that they merely project like small knobs above the surface of the oral disk.

The oral fissure is bordered by twelve broad, swelling papillæ, of which two at either end enclose the entrance to the œsophageal grooves. They are stronger than the others, and are, moreover, divided by a horizontal furrow into two swellings lying one above the other. Whilst the œsophagus itself is short, its sagittal prolongations, the œsophageal lappets are very long, and extend nearly as far as the pedal disk.

The number of the septa is very large, and in the oldest animal amounted to ninety-six pairs, which were distributed in five cycles. In many places there were additional indications of the ninety-six septa of the sixth cycle, which however merely projected as thin folds between the wall and the pedal disk, and as yet had no mesenteric filaments.

We can generally distinguish two parts in the septa, one thick walled and muscular, the other delicate and veil-like (fig. 12). The former lies on the wall; its longitudinal fibres spring not only from the pedal disk but also from the lower part of the wall, and converge towards the oral disk and the œsophagus, especially towards the base of the tentacles. We cannot precisely talk of a special longitudinal muscle, but still the fibres are more thickly compacted in the middle of the lamella and united into thick cords, showing the following figure in transverse section (Pl. VII. fig. 6). Underneath each cord lies a thickening of the supporting substance of the septa, which sends out bushily branched folds of connective tissue in all directions, and these again bear the richly pleated muscular lamella. The whole is covered with epithelium, which also has hollows corresponding to the depressions between the ridges of connective tissue, so that the inequalities caused by the distribution of the muscles also become visible externally.

The transverse muscles, which run from the wall principally towards the stomach, but

also towards the oral disk and pedal disk, are weak in the lower parts, but very strong at the upper end. The upper portion draws the oral disk very energetically towards the wall, and is assisted in this by part of the longitudinal fibres. The interspace between the oral disk and wall is here reduced to a minimum, which renders the separation of detached single septa more difficult. The parietobasilar muscle is moderately strong in most septa, and does not even extend up to the third of the height of the animal; it is not merely connected with the septum by epithelial adhesion, but by coalescence, as the supporting lamellæ of both parts are fused to a great extent. The epithelial lamellæ and the muscular fibres of the surfaces of the parietobasilar fold and the septum which are turned towards one another still remain, however, here and there between the fused streaks of the supporting lamellæ, and in transverse section originate circular figures which are enclosed in the connective substance, and indicate by their serial arrangement the boundary between the septum and the fold.

Two kinds of stomata are found in the muscular part of the septa; the peristomial are very large, whilst the marginal, which lie close to the wall, are small, and, in fact, so small in the oldest septa that they are almost entirely obliterated.

The thin-membraned veil-like part of the septum is only furnished with a weak layer of muscles, and bears both the mesenteric filament, which is fastened to its free margin, and the reproductive elements, which in *Dysactis* are not rolled up into compact masses as they are in most Actiniæ. The follicles of the testes in the male, the ova in the female are scattered over the supporting lamella, which, consequently, has the look of being strewed with isolated star-like points. The filamental apparatus appeared to be present in the ova.

A remarkable diversity usually prevails in the development of the septa. The directive septa are very small, but, on the other hand, they are connected to a great extent with the œsophagus, as the latter, in correspondence with them, is produced into the long œsophageal lappets, which reach nearly to the pedal disk. The thin-membraned part is small; all the muscles, especially the parietobasilar muscle, stronger than of any other septa; reproductive organs wanting throughout. The directive septa agree in the last respect with the other principal septa, and also with the six pairs of septa of the second order, which are chiefly distinguishable from the principal septa by not extending so far on the œsophagus. We first find the reproductive elements richly developed on the twelve pairs of septa of the third order; they are present on all other septa, with the exception of the unimportant rudiments of those of the sixth order; on the other hand, the muscular parts of the septa become almost imperceptible, and they themselves no longer project so distinctly into the gastric space. Only the septa of the third and fourth orders still reach the œsophagus, though their insertion occupies no great space; the septa of the fifth order end on the oral disk.

It is remarkable that from the third cycle of septa onwards, the septa of one and the

same pair are never of the same size, so that for example half of the septa of the fifth cycle are inserted at a considerable distance on the oral disk, whilst the other half run only to two-thirds of the height of the wall. Closer investigation shows that this difference of size is governed by fixed laws. From the moment when the septa of the first two cycles are developed onwards, we find that after these all the interseptal spaces are bounded by septa of different grades, *i.e.*, by a septum of a higher and a septum of a lower order. The propinquity of the former causes a stronger development, *e.g.*, in the newly-formed pairs of the third order, the septum turned towards the older pair is always stronger than the other. In the following pair of the fourth order, the septum which adjoins the septum of the third order is always the smaller. These differences cannot, of course, arise in the second cycle, as the interseptal space lies between septa of the first order which are of equal value.

As *Dysactis crassicornis* is not found at any great depth, and was dredged up by the Challenger at several places, the probability that the animal may have come under the observation of former naturalists deserves special consideration. Let me draw attention to two forms which are perhaps identical with it. In the Annals and Magazine of Natural History, 1872 (series iv., vol. ix. p. 304), Kyle describes an Actinia which he procured by means of the hooks on fishermen's deep-sea lines. Like the form under discussion, this Actinia reminds us of *Tealia crassicornis*, but differs from it in having a smooth body surface which brings it nearer our *Dysactis*. The second Actinia is the *Rhodactinia davisii*, minutely described by Verrill (Mem. Boston Soc., vol. i. p. 18, 1866–69), in which the papillæ on the wall are so indistinct that the surface appears almost smooth. The tentacles also appear to be similar, and, according to Verrill, are numerous, and arranged in several indistinct rows; they are conical or cylindrical, thick, rather short, rounded obtusely at the end or even club-shaped. There is, however, some doubt about this second form, as Verrill himself identifies it with *Tealia crassicornis* or rather *Urticina crassicornis*, as he terms the species (Transactions Connecticut Acad., vol. i. p. 469).

Dysactis rhodora.

Actinia rhodora, Couthouy, in Dana,[1] Explor. Exped., Zooph., p. 148, pl. iv. fig. 37, 1846 (Synopsis, p. 11).

Dysactis rhodora, Milne-Edwards, Hist. des. Corall., tom. i. p. 263, 1857.

Tentacles tolerably long and slender, arranged in three rows; the tentacles of the inner row essentially longer and stronger than those of the middle and outer rows.

Habitat.—Station 313. January 20, 1876. Lat. 52° 20′ S., long. 68° 0′ W. Depth 55 fathoms. Two strongly-contracted specimens.

[1] The edition of Dana's chief work, Report on the Zoophytes of the U.S. Exploring Expedition, which appeared in 1846, was very limited, and was soon out of print; the author therefore subsequently (1859) published a synopsis. I was only able to refer to the synopsis and the atlas, for the loan of which I am indebted to the kindness of Prof. Hæckel. The quotations referring to the large work are taken from Milne-Edward's Histoire des Coralliaires, whilst I have myself looked over the synopsis and the atlas.

All the quotations have been verified in the Challenger Office by reference to the original work.—J. M.

Dimensions.—Pedal disk, 2·5 and 1·5 cm.; height, 1·2 and 0·5 cm.

The two Actiniæ, which I shall now briefly describe, belong to that class of specimens in which the shape of the body has been so decidedly modified by the high grade of contraction, and the colour is so completely gone from the action of the alcohol, that we must observe very great caution in referring them to any species hitherto figured and described. We must also bear in mind that in the case before us, even the larger specimen under examination is not yet mature, and we must therefore consider that the structure may undergo considerable changes in the course of growth.

The pedal disk and wall are tough-walled; they seem to have been perfectly smooth in a fresh condition, and only to have become irregularly wrinkled and pleated in consequence of being preserved. The wall is thickened two or three-fold for a short space at the upper end by the circular muscle. The latter is separated from the endoderm by a narrow layer of connective substance, and greatly resembles in form the circular muscle of *Tealidium cingulatum* figured in Plate VI. fig. 2. Seen in transverse section, it widens towards the upper end like a club, though not so strikingly; towards the lower end it runs out into a fine point, by which it nearly reaches the endoderm. The bundles of fibrillæ are formed of a few very strong fibrillæ, which are apposed one to the other in form of a ring in transverse section; they are separated by a sparse layer of interstitial substance, and are only indistinctly arranged in larger and smaller groups. The smallest bundles are found towards the lower pointed end, where they often merely consist of from three to four fibrillæ.

The tentacles, whose number may be roughly estimated at about a hundred, are placed in three circles, the innermost are the longest and decidedly the strongest; they measure more than 0·6 cm., even in the contracted animal, whilst the outermost present very thin filaments only 0·3 cm. in length. I could not perceive any terminal openings. The muscular system on the surface is a repeatedly folded layer of ectodermal fibres, which also pass uniformly on to the oral disk. By this difference, and also by the varying character of the circular muscle, *Dysactis rhodora* can be at once distinguished from *Dysactis crassicornis*, in which the muscles of the oral disk and the tentacles have passed into the mesoderm, whilst the circular muscle lies close under the endoderm.

Any description of the œsophagus would be of little interest. I shall therefore pass this over, and proceed at once to discuss briefly the septa, the regularity of whose arrangement is remarkably clear in section. There are in all four orders; the six pairs of principal septa and the six pairs of secondary septa are perfect, and only distinguishable from one another by the former being more muscular than the latter. The septa of the third order are imperfect and essentially smaller, whilst the last septa are narrow, thin lamellæ. In the quadrant, used for investigation, the septa of a cycle

were of equal size throughout, and showed a very unusual regularity of development. Directive septa are present, as I have proved from direct observation.

The longitudinal lamella is not very strong, but pleated in a large part of the septa. The parietobasilar muscle reaches half-way up the wall; it is partly fused with the septum, partly laid on it in loose folds.

Finally, the two kinds of openings, already known in various other Actiniæ, are found in the perfect septa; from their small size they might easily be overlooked, though I have observed them in dissected septa, both seen from the surface and in transverse section.

Tealidium, Hertwig.

Paractidæ, having the tentacles placed in several rows and of uniform size in the same row, and having the wall covered with fine papillæ.

As I limited the genus *Tealia* (see p. 34) to animals with an endodermal sphincter, projecting in the form of a swelling into the stomach, it became necessary to form a new genus, which I have named *Tealidium*, for all forms which agree with the Tealidæ in the papillose nature of the wall, but which differ from them in the mesodermal position of the sphincter. I consider it of no importance whether the papillæ are regular or irregular, compacted or scattered, or whether the wall is incrusted with foreign bodies or not. On the other hand, I have included the uniform character of the tentacles in the diagnosis, for I regard *Tealidium* as a genus parallel to *Paractis*, which it resembles except in one distinguishing point, viz., the warty nature of the body surface.

Tealidium cingulatum, Hertwig (Pl. III. fig. 3; Pl. VI. fig. 2; Pl. VIII. figs. 7, 8).

Tentacles small, placed in two rows; the mesodermal circular muscle projecting as a circular swelling from the outer surface of the wall; the wall covered with numerous longitudinal furrows, corresponding to the origins of the septa.

Habitat.—Station 158. March 7, 1874. Lat. 50° 1′ S., long. 123° 4′ E. Depth, 1800 fathoms. One specimen.

Colour.—(Determined from the spirit specimen) pale saffron yellow.

Dimensions.—Diameter of the pedal disk, 1 cm.; height, a few millimetres.

The single specimen of *Tealidium cingulatum*, which was taken attached to a stone from a depth of 1800 fathoms, belongs to the smallest forms among the Challenger material. It is so strongly contracted that the wall closes over the entrance to the oral disk till only a small opening is left. I could therefore neither determine the extent of the oral disk nor the height of the body, and the only means of determining its size was the diameter of the pedal disk, which amounted to about 1 cm. The colour of the body, if it has not been changed by the influence of the alcohol, is a delicate saffron-yellow.

Twenty-seven sharply-defined longitudinal furrows can be counted on the wall; they

begin at a little distance from the margin of the pedal disk, become less distinct as they run upwards, and disappear towards the margin of the peristome. Besides the furrows the body is covered with numerous small papillæ, which can only be distinctly recognised with the magnifying glass, and which show a pattern like shagreen on the wall, as they are all of the same size and closely compacted. The entrance to the oral disk is surrounded by a circular swelling projecting above the surface, which belongs to the upper end of the wall; a shallow circular furrow runs near the lower end at a short distance from the margin of the pedal disk.

Nothing further could be observed in the uninjured animal, and on account of its smallness and strong contraction no further results could be expected from a dissection with scissors and knife. I therefore cut out a piece about the size of a quadrant, in which I examined the circular muscle, the oral disk, the tentacles, the œsophagus, and the septa in transverse sections, changing the plane of the section as occasion required.

The circular muscle, which lies in the mesoderm, is so powerful in *Tealidium* that the bulk of it has not room enough in the thickness of the wall. Just as a purely endodermal circular muscle causes a circular swelling on the inside, so this strong mesodermal muscle causes a similar swelling on the outside, as the surface of the wall is arched out to nearly four times the usual thickness; it can be recognised by simply looking at the animal, and has already been briefly mentioned. It probably becomes still more apparent when the *Tealidium* is extended, and then produces a girdle under the origins of the tentacles, on account of which I have named the form *Tealidium cingulatum* (Pl. VI. fig. 2). The entire mass of the muscle is club-shaped in transverse section. The smaller end, which is turned downwards, runs out into a fine point, which extends nearly to the endoderm, through the broad intermediate layer of connective substance.

The separate muscular fibres are fine, and so are the primitive bundles formed by them; from the manner in which the latter are grouped, it seems probable that they arise from division of larger bundles, of which a few still remain (Pl. VIII. fig. 8). The process of division seems to go on very rapidly in the peripheral parts, as we there find not only groups of two, three, and four fibrillæ enclosed in the fibrous connective substance, but very frequently completely isolated single fibrillæ (Pl. VIII. fig. 7).

There was nothing remarkable about the oral disk and the tentacles; their radial longitudinal muscular fibres are ectodermal, and extend in an almost smooth layer, which is only distinctly pleated at the bases of the tentacles. The number of the tentacles which are distributed in two circles amounts to twenty-four; they are of no great length, so that they are completely hidden under the contracting circular muscle.

The number of the septa in the quadrant examined amounted to seven; as they usually correspond to the longitudinal furrows already mentioned, their number in the entire animal must be reckoned at more than twenty. Their paired arrangement is shown by the course of the muscles; two directive septa were present in the quadrant, so that there is no

reason why we should not regard the animal as conforming to the common plan of the Actiniæ. The result would therefore be that the animal has altogether two cycles or twelve pairs of septa. All the pairs of septa are quite uniform, all reach the stomach, and all bear reproductive organs. In the case before us, the latter are mature testes, closely filled with separate follicles of spermatozoa. As usual the tails of the spermatozoa lie inwards, the heads outwards, the former converge at the same time towards a point in the surface where the follicle projects into the epithelium, and where it probably bursts later on, in order to empty out its contents.

Antholoba, Hertwig.

Metridium, Milne-Edwards, *pro parte*. Hist. des Corall., tom. i. p. 252.

Paractidæ with innumerable small tentacles, which lie on a swollen thickening of the margin of the disk; margin of the disk lobed as in *Metridium*.

After Oken had erected the genus *Metridium* for the beautiful *Actinia Plumosa s. dianthus* (Lehrbuch d. Naturgeschichte, Th. III. Abth. 1, p. 349, 1815), Milne-Edwards included in it all the forms which agreed with the typical representatives in the peculiar arrangement of the tentacles and in the beautiful wave-like form of the lobes which border the oral disk. The probability that animals which resemble each other externally may differ essentially in their internal organisation was quite overlooked.

This is, in fact, the case, as I have proved from my own observation. It is quite correct to place *Metridium dianthus* among the Sagartidæ, since, in it as in them, only the six pairs of principal septa reach the œsophagus, and, according to Gosse (Actinologia Britannica, p. 20), are also furnished with acontia. *Metridium dianthus* differs in both these points from an Actinia, which was first observed by Dana, and was erroneously added to the genus *Metridium* by Milne-Edwards (Histoire des Coralliaires, tom. i. p. 253) and Verrill (Trans. Connect. Acad., vol. i. p. 479). In this Actinia the acontia are wanting, and the septa for the most part perfect as in the Paractidæ. Other conditions, such as the presence of a mesodermal sphincter, also show that this Actinia is a true Paractid. I therefore propose to form the new genus *Antholoba* for these forms which externally recall *Metridium*, but which, on the other hand, have no acontia, and are furnished with numerous perfect septa as well as with a mesodermal sphincter.

Antholoba reticulata (Pl. I. fig. 9; Pl. X. figs. 11, 12; Pl. XIII. fig. 9).

Actinia reticulata, Couthouy, in Dana, Explor. Exped. Zooph., p. 144, pl. iv. fig. 31, 1846 (Synopsis, p. 10).
Metridium reticulatum, Milne-Edwards, Hist. des Corall., tom. i. p. 255, 1857.
Actinoloba reticulata, Gosse, Actinologia Britannica, p. 24, 1860.
Metridium reticulatum, Verrill, Trans. Connecticut Acad., vol. i. p. 479, 1871.

Margin of the disk five-lobed, with several thousand small tentacles, the twelve tentacles of the first and second cycles larger than the others, and placed towards the centre at a

little distance from them; the thirty-six following still easily recognisable; the wall traversed by reticulated furrows; mesodermal muscle developed throughout the entire length of the wall.

Habitat.—Station 313. January 20, 1876. Lat. 52° 20′ S., long. 68° 0′ W. Depth, 55 fathoms. Three specimens.

Dimensions.—Diameter of the oral disk, 3·5–6·0 cm.; height of the body column, 2·0–2·5 cm.

The three specimens of *Antholoba reticulata* included in the Challenger material were admirably adapted for examination, as the body was only slightly contracted. This applied especially to the largest specimen, which was 6 cm. broad and 2·5 cm. in height, and upon which the following observations have been principally made.

The pedal disk is very thin walled, so that the insertions of the septa shine through it as innumerable clear lines; the margin is indistinctly lobed, probably five-lobed like the margin of the oral disk. The firm compact wall of the Actinia rises in a curve at an acute angle from the pedal disk, and is constricted more or less distinctly at a third of its height. The lower part of the wall is traversed by circular furrows, which are perhaps merely caused by the contraction of the muscles of the body, its upper part is covered with soft papillæ, about 0·5–1·5 mm. broad, which are not sharply separated, lie close together, and are very much flattened. Shallow furrows, which give the surface of the body its reticulate appearance, and which Couthouy had in view in naming the species, remain between the papillæ.

The mesodermal circular muscle is never very strong, but, on the other hand, it extends from the upper to the lower end of the wall, a formation which I have never found in any other Actinia. In longitudinal section it can be distinguished by the naked eye as a yellowish layer, situated close under the endoderm, which is 0·5 mm. broad in its upper third, but diminishes as it runs downward (Pl. XIII. fig. 9). Its bundles of fibrillæ (Pl. X. fig. 11) are all very small but thickly compacted, and only separated by a little connective substance; they are all strongly flattened in the same direction in such a way that their edges lie perpendicular to the endodermal epithelium. They have an inclination to lie one behind the other in rows, which run outwards from the epithelium, and in this way they have the appearance of being produced by the breaking up of long thin muscular plates. The large bundles of fibrillæ are found on the outside, but the smaller ones inside, close under the endodermal layer of circular fibres, which is repeatedly pleated over them. From all this it seems probable that small bundles of fibrillæ are continuously detached by pleating from the endodermal layer, and are transformed by growth into larger bundles in the depth of the layer.

At the upper end the wall passes gradually into the oral disk, the margin of which is swollen like a pad. The limits of the disk are indicated by the appearance of the tentacles and the disappearance of the circular muscle.

The oral disk is five-lobed, its periphery being delicately sinuated; its upper third is so thickly strewn with small tentacles that it is impossible to determine their number, though we may estimate them at from two to three thousand; they are all very slender, thin-walled, and cæcal; they are largest towards the centre of the disk, and become smaller towards the periphery. Twelve tentacles, which are particularly conspicuous from their size, lie somewhat apart from the rest, nearer the centre of the oral disk, so that they are isolated from the others. They are distributed at equal distances round the oral fissure in such a way that two of them correspond to the corners of the mouth; this mode of distribution leads us to conclude that they belong to the intraseptal spaces of the six pairs of principal septa and the first six pairs of accessory septa. Outside these come thirty-six other tentacles, which make up a circle; twelve of these alternate with the first twelve, the other twenty-four falling between the latter and the former. The thirty-six tentacles can hardly be defined from the peripheral principal mass, because, in the first place, there is hardly any interspace between them, and, in the second place, because they are but slightly superior in size. They belong to the tertiary and quaternary intraseptal spaces. By dissecting the septa, the peripheral mass of small tentacles may also undergo examination, the result of which is to show that they all lie in different radii of the body. We never find more than one tentacle in communication with the same intraseptal space, though such a result seems highly probable on mere superficial examination. All the tentacles belong primarily to a single circle, and have only been forced into different circles by want of space.

The radial muscular system, which in this case also lies in the mesoderm, shows the same characters as those which we have already observed in the circular muscle. The mesoderm is pleated in transverse section, and, in well preserved animals at least, is covered with a layer of radial fibres; the mesodermal bundles of fibrillæ are flattened and placed in rows which begin in the pleating on the surface of the mesoderm and run straight towards the inside. We may say that we have before us deep laterally compressed folds, which fall asunder into numerous bundles of fibrillæ placed one below the other (Pl. X. fig. 12).

The layer of muscle is strongest between two septal insertions, and the mesoderm consequently slightly thickened. In this way radial swellings are formed on the oral disk, which, however, become more perceptible in transverse section than when looked at from the surface of the oral disk, and more perceptible near the tentacles than in the periphery of the mouth.

The oral opening rises slightly like a proboscis above the surface of the oral disk, and forms an oval fissure, one end of which is directed towards one of the points where the margin of the oral disk arches inwards, and the other end to a point where it arches outwards. The two œsophageal grooves are remarkably distinct on the œsophagus, as they are enclosed by high lips, which project like combs, corresponding to which the

œsophageal lappets extend downwards, far into the stomach. The upper half of the œsophagus shows about twenty longitudinal ridges which are prolonged lower down into a larger number of smaller ridges. The boundary between the oral disk and the œsophagus is defined by a sharp line.

The septa (Pl. XIII. fig. 9) are very simple in construction, as specially differentiated muscles (retractor and parietobasilar muscle) are wanting, and the two primitive layers of muscles only are present. Transverse muscles, which run obliquely between the wall on the one hand and the oral disk, œsophagus, and free margin of the septa on the other, extend on one side, and are strongest in the upper and lower third, where their lamellæ are repeatedly folded; on the other side run parallel longitudinal muscles also in a repeatedly folded layer from the pedal disk to the oral disk and the œsophagus. In the perfect septa a small peristomial opening lies hidden in the angle formed by the junction of the proboscis-like part of the oral disk with the œsophagus.

As may be concluded from the large number of the tentacles, the number of the septa is something quite unusual, even though many of them have stopped growing at a very early stage. The septa of the second and third cycles are perfect as well as the principal septa, and are easily distinguished from one another by the difference in size and by the extent to which they descend on the œsophagus. Of the imperfect septa, those belonging to the fourth and fifth orders are still well developed; after that they decrease rapidly in size, so that the other septa almost come to be mere folds projecting more or less in the angles on the upper and lower end of the wall. This recalls the comportment of the tentacles in which the first four to five cycles are the most easily distinguished.

In order to obtain a general idea of the aggregate number of the septa, I prepared an intraseptal space of the third order as completely as possible, and made a transverse section through it, which passed through the upper part of the wall and the peripheral part of the oral disk. In this section I found more than sixty separate septa. This would give over 1500 septa, or over 700 pairs of septa for the entire animal. There appear, therefore, on the whole, to be eight cycles or 768 pairs of septa. There may perhaps be traces of a ninth cycle, as each interseptal space of the eighth order is furnished with at least three tentacles.

I can say nothing as to the distribution of the reproductive elements on the septa, as their thin-membraned parts had stuck together and were badly preserved. Some figures which I got in the sections lead me to believe that *Antholoba* may possibly be hermaphrodite. This would be very unusal, as I have as yet only observed hermaphroditism in *Cerianthus* and *Scytophorus*.

Ophiodiscus, n. gen.

Paractidæ with a single corona of long tentacles, which project at the margin of the wall and oral disk, and are only furnished with muscles on the upper side; wall smooth, with longitudinal furrows, indicating the insertions of the septa; septa differentiated

into muscular septa and reproductive septa. The animals do not appear to draw the oral disk over the mouth, though a mesodermal muscle is present.

The external appearance of the Actiniæ, for which I have formed the new genus *Ophiodiscus*, recalls that of *Anthea cereus*, as the tentacles are of great length, project in a single row on the outer margin of the oral disk, where it is turned over into the wall, and hang down like flowing hair over the side walls of the body. The margin of the wall was also not drawn over the oral disk as in the Paractidæ. It would, however, be rash to conclude from the form presented by the animals before me that they are quite incapable of concealing the oral disk, and the more so as I succeeded in finding a mesodermal sphincter. It is possible, however, that, considering the size of the body, the sphincter is not very strongly developed, so that the contraction caused by it is a slow process.

A further point which distinguishes *Ophiodiscus* from the other Paractidæ is the constitution of the tentacles. As one wall of the tentacles is formed by the prolongation of the body wall, the other by the prolongation of the oral disk, they show the same differences in the distribution of the muscles which characterise the said sections of the body wall. The former only has longitudinal muscles, the latter is without muscles and is correspondingly thinner walled.

The differentiation of the septa into sterile septa with muscles and reproductive septa with weak muscles is still more important. The latter are extremely rudimentary, and have even lost the mesenteric filaments; whilst in other Actiniæ a distinct graduation in size prevails in the separate cycles of septa, there is a pronounced distinction between the smallest muscular septa and the reproductive septa. It may be advisable at some future time to erect this form into a special family.

Ophiodiscus annulatus, n. sp. (Pl. X. figs. 1–10).

Wall surrounded close below the tentacles by numerous circular furrows, caused by the sphincter, which become less distinct towards the lower part of the wall.

Habitat.—Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W. Depth, 2160 fathoms. Four specimens.

Dimensions.—Height, 0·5–1·8 cm.; breadth of the oral disk, 2·0–4·5 cm.; breadth of the pedal disk, 1·0–3·5 cm.

Before proceeding to describe *Ophiodiscus annulatus*, I wish to make a few preliminary remarks as to the state of preservation in which I found the animals in question. It was unfortunately extremely unsatisfactory, which I regret the more as they are a particularly interesting form. In all the specimens the tentacles were tattered and frayed out at the end, and there were rents here and there in the wall between the insertions of the septa. The largest specimen was so much destroyed that I could not take any measurements from it. All this must be ascribed to the fact that the animals came from a great depth, and had been injured in hauling up the dredging apparatus. The animals have, moreover,

suffered from having been pressed closely one against the other in the same bottle, so that they are flattened, and the relief of the body surface rendered indistinct. The dimensions given above and the following description of the form of the body are therefore merely of hypothetic value; the unfavourable state of preservation also explains why I have omitted to give exact numbers in describing the different parts of the body.

The height of the body in the living animal seems to have been small, its breadth essentially greater in the region of the oral disk than at the base, so that the whole form of the body may be termed "dish-shaped." It is divided into an upper broader and a lower narrower section by a deep circular constriction. Nearly one hundred tentacles, probably of astonishing length, hang down from the margin of the oral disk. In the smallest specimen there was still one tentacle which extended into a thin filament, 8 cm. long. I grant that this measurement may have resulted from the tentacle having been forcibly stretched, but considering that the diameter of the animal itself only amounts to 1·0 cm., we may safely assume that the length of the tentacles exceeds the former several times. This is also perhaps the reason why the tentacles are nearly all torn away. Whether the tentacles of each different order are of equal size or not, can only be determined by examination of other specimens.

The surface of the wall (fig. 1) is marked by about one hundred longitudinal furrows, which lie at equal distances from one another, correspond to the origins of the septa, and pass as radial streaks on to the pedal disk. Besides these longitudinal furrows, horizontal furrows run in the upper fourth close under the corona of tentacles, parallel to the margin of the oral disk; the swellings between the circular furrows are broadest above, whilst they become narrower and flatter below. The swellings and furrows are more pronounced on the endodermal side than on the ectodermal; at the same time we see in longitudinal section (fig. 6), that the internal furrows correspond to the external swellings and *vice versa*, so that the wall is pleated transversely. Its substance is, moreover, partially thickened, and it is on account of these partial thickenings that the swellings project more towards the inside than towards the outside.

The thickening and pleating of the wall are caused by the mesodermal circular muscle, whose bundles of fibrillæ are arranged close under the endoderm in layers, which run parallel to the surface and follow all its pleatings. There are from nine to ten such layers inside the uppermost and broadest swelling (fig. 6, α); they gradually decrease in number, in the middle (fig. 6, β) there are only about four, and later (fig. 6, γ) only two, till finally the circular muscle extends a little way in the now flat part of the wall as a single layer of small bundles which continue to become more sparse (fig. 6, δ). The separate muscular fibrillæ are remarkably thick, whilst the bundles formed by them are small, and as usual compressed in the direction of the longitudinal axis of the animal. The smallest bundles lie immediately below the epithelium, from which they appear to be formed, as shown in figs. 7, α, β.

The surface of the oral disk is smooth, or only indistinctly furrowed radially; if examined in transverse section (fig. 5) it shows a set of strong mesodermal muscles, a broad band, separated both from the endoderm and the ectoderm by a layer of supporting substance. This band is broken by a separating bar of connecting substance, corresponding to the insertion of every septum. It is further a law of its development that the supporting substance grows out strongly into the muscular band from the endodermal and ectodermal sides alternately, and forms ridges from which ramified supporting layers stretch towards the opposite side. In this way smaller and larger elongated compartments are formed, which are filled with muscular fibres. These muscular fibres, like those of the wall, are extremely thick, and the manner in which they pass on to the tentacles distinguishes the *Ophiodisci* sharply from other Actiniæ.

Although the tentacles were badly preserved, it was perfectly clear that they are thin-membraned on one side but thickened on the other (fig. 2). This thickening is caused by a muscular cord which can be followed even with the naked eye as a broad fibrous streak running from the oral disk to the tentacle. It occupies that side of the tentacle which is turned upwards in a state of rest, and projects at its base right and left a little above the surface. It thus forms two wing-like expansions which pass a little way on to the oral disk. The structure of this cord is the same as that of the muscular band of the oral disk; it is composed of strong, thickly compacted muscular fibres, divided by thin layers of connective substance into compartments of muscular fibres.

Muscular fibres are wanting in the thin membraned parts of the tentacles, unless they be present in the ectoderm, which could not be determined, as the ectoderm was completely macerated away. Whilst the muscular cord passes into the oral disk, the thin membraned parts of the tentacles, on the other hand, are prolongations of the wall. This is brought about by the fact that the tentacles lie exactly on the border line at which wall and oral disk are united.

Before passing into the œsophagus, the oral disk is raised in the periphery of the mouth into a proboscis-like projecting lip. The proboscis is marked on either side with about ten longitudinal furrows, and is likewise furnished with two œsophageal grooves, which are enclosed by two strong longitudinal folds, hard as cartilage, and pass downwards on to the long œsophageal lappets. In one specimen the lower part of the œsophageal grooves appeared closed into a tube by fusion of the margins of the folds.

The number of the septa amounted in all to forty-eight pairs, which are distributed in four cycles. The first three cycles, that is, the first twenty-four pairs, are formed exclusively of muscular septa which do not bear reproductive organs; of these the septa of the first two cycles only reach the œsophagus, the remaining twelve pairs are imperfect. Septal stomata are wanting. The muscles are slightly developed, for I could not even find a parietobasilar muscle. In consequence of insufficient preservation, the free margins of the septa had become frayed out, and only part of the mesenteric filaments remained (fig. 4).

In contrast to the sterile muscular septa, it is the last twenty-four pairs of septa which alone bear the reproductive organs (fig. 4, *g*), but, on the other hand, have neither muscles nor mesenteric filaments; they have, moreover, undergone retrograde formation, for they merely project as small folds in the angle between the wall and the pedal disk, and only extend up the wall as far as the circular constriction described above. We can distinguish two parts on each septum, the free margin, which is thickened by the layers of reproductive elements and much folded, and a thin veil-like membranous part which, like a mesentery, fastens the reproductive organ to the pedal disk and wall.

The septa of a reproductive pair are always unequal in size, and that one of them is always the largest which stands next the muscular septum of the higher order.

Enveloped in the same bit of cloth as the four specimens of *Ophiodiscus*, there was a peculiar, dendritically branched body, which may possibly have belonged to one of the animals as an appendage of the wall from which it had been torn away; I shall therefore give a supplementary description of it.

The pseudo-tentacle—as I shall term it in what follows, though I do not wish to settle its signification—is a very dainty, delicately-walled formation (fig. 8); a short basal stem is almost immediately divided into numerous branches, and these, undergoing repeated dichotomy, finally form a terminal bush of club-like twigs. The principal branches frequently anastomose, so that it is difficult to subdivide the brush of tentacles according to its principal ramifications, which, moreover, form here and there small vesicular swellings.

By the help of weak magnifying power we can make out accurately the nature of the ramification and the form of the twigs (fig. 9). Each new branch is separated from the preceding by a circular constriction, and begins and ends with a small swelling. One of the twigs formed by dichotomy is usually behind hand in becoming branched, and this is specially apparent at the ends. These present three points, as one of the twigs caused by the last bifurcation only is redivided, whilst the other remains simple.

Like the tentacles, the pseudo-tentacle contains a hollow space, which is without doubt an evagination of the gastrovascular system; we can also distinguish three layers, an inner layer, probably endodermal, an outer, ectodermal, and the intermediate supporting lamella. Within the latter small fusiform cells are enclosed in a perfectly homogenous fundamental substance (fig. 10). Strong, circular muscular fibres run in the ectoderm; seen from the surface these caused an annulation of the branches which becomes less distinct at the ends. Transverse and longitudinal sections are necessary in order to make out the position of these fibres. In these sections I also observed fine fibres on the endodermal side; they were arranged longitudinally, and consequently crossed the course of the others. They also seemed to be of a muscular nature.

The epithelial layers were badly preserved, the ectodermal layer all but wanting, and the endodermal merely showed a thin layer of protoplasm with scattered nuclei.

What grounds have we for assuming that the structure described above is a com-

ponent part of an *Ophiodiscus?* From the structure of the organ we may assume one thing, that it belongs to a Cœlenterate, as it shows the three body layers which characterise these animals; the presence of cells in the supporting lamella makes it still more probable that it belongs to an Actinia. There is therefore nothing in the structure which goes against this view, but what is greatly in favour of it is the fact that the pseudo-tentacle and the Actinia were found in the same envelope, not accidentally, but because they belong to one another.

In fact there are descriptions published of Actiniæ which bear richly branched bush-shaped appendages as well as tentacles. Such, for example, is *Lebrunia*, found by Duchassaing and Michelotti in the Antilles (Memoire sur les Coralliaires des Antilles, Memorie della R. Accademia di Torino, ser. ii. t. xix. p. 324, pl. vii. fig. 8). The only species of the genus, *Lebrunia neglecta*, bears outside the corona of long simple tentacles five composite tentacles, which spring from the wall, and dichotomise till they run out into numerous terminal branches. The general habit of body of the four Actiniæ examined by me also recalled *Lebrunia*, inasmuch, as appears from Duchassaing's plates, the tentacles also spring from the outermost margin of the disk and hang down like hair over the wall.

I endeavoured to find remains of pseudo-tentacular appendages on the walls of the four specimens, but my attempts were unsuccessful, which is not to be wondered at considering the injuries which the animals have suffered, and that if these occasioned the loss of the stronger tentacles, it is likely that the very delicate pseudo-tentacles have been completely destroyed. Whether *Ophiodiscus* be related to *Lebrunia*, and might even be placed with it in a common genus, or whether they have absolutely nothing in common, remains therefore an open question. If the drawing given by Duchassaing of the branched pseudo-tentacles be true to nature, they differ so widely from the pseudo-tentacle described above, that it would be advisable at least to separate the species.

Ophiodiscus sulcatus, n. sp. (Pl. III. fig. 8).

Wall smooth; oral disk covered with numerous radial, deeply sunk furrows; body discoid.

Habitat.—Station 300. December 17, 1875. Lat. 33° 42′ S., long. 78° 18′ W. Depth, 1375 fathoms. One specimen.

Dimensions.—Diameter of the oral disk, 9 cm.

In fig. 8 of Plate III. I have endeavoured to reconstruct an Actinia, which was so completely tattered that a superficial examination could hardly recognise an Actinia in the whitish mass. I succeeded by careful apposition of the parts in restoring the whole of one half and the greater part of the other half; I also discovered the œsophageal grooves, and in this way, determined the sagittal plane, so that I believe the drawing accurately reproduces the essential points of the animal's habit of body. In preparing the drawing I copied the one half, extending from one œsophageal groove to the other, as accurately

as possible, and filled up the other half which was still more torn. I have only given the bases of the tentacles, as they were either only preserved in short pieces or were torn away close to the body of the animal.

The pedal disk is much smaller than the oral disk, and is covered with numerous radial ridges, somewhat in the same way as in *Polysiphonia tuberosa* (Pl. IX. fig. 5). The wall is smooth and tolerably thick-walled; its upper part contains a mesodermal circular muscle, which is very weak in proportion to the size of the animal, both in extent and in the number of its bundles of fibrillæ and the strength of the single fibres. On the other hand, powerful masses of muscle are accumulated in the oral disk. The latter is covered with deeply sunk furrows, which begin between the bases of the tentacles and run in a radial direction towards the oral opening. The furrows end in the periphery of the mouth, which is somewhat swollen, and at which two adjacent furrows are sometimes united. The swellings between the furrows, which are sometimes narrow sometimes broad, are caused by the deposition of strong mesodermal muscles. Their structure resembles that already described in *Ophiodiscus annulatus*, except that the bundles of fibrillæ are much more numerous, and form a layer which is at least twice as strong. The number of the radial swellings in the well-preserved half amounts to twenty-four, therefore to forty-eight in all.

There are likewise forty-eight tentacles which spring exactly from the junction of the wall and the oral disk, one of their walls representing a prolongation of the former, the other a prolongation of the latter. The thick muscular cords therefore only pass on to one side of the tentacle walls, whilst the other consists merely of supporting substance.

Though only a few of the septa were preserved, these were sufficient to show that they are distributed in alternate pairs of muscular and genital septa. The genital septa are thin-walled, whilst the muscular are strengthened by a thick supporting lamella. As there are in all forty-eight tentacles, the number of the muscular septa also amounts to forty-eight or twenty-four pairs.

The above statement suffices to prove that *Ophiodiscus sulcatus* is very closely allied to *Ophiodiscus annulatus*, but distinguished from it by the absence of annulation of the wall and by the strong formation of furrows in the oral disk. The two forms may even represent one and the same species, and the differences merely arise from difference of age. At any rate they were both taken at a great depth in two localities, geographically not far apart.

It is also well worthy of our consideration that in no other Actinia did I find the tentacles so shattered as in the two species before me, not even in specimens dredged from still greater depths. This may perhaps have to do with the fact that the animals attach themselves to foreign bodies by their muscular tentacles. I have already specially remarked that the tentacles are probably of great length in the living animal, so that they would be especially adapted for holding on to other objects.

LIPONEMIDÆ, Hertwig.

Hexactiniæ with numerous perfect septa and with marginal tentacles transformed by retrogade formation into short tubes or into stomidia.

Among the Actiniæ of the Challenger material there were some forms in which the tentacles had undergone a greater or less degree of retrograde formation. One part of these, *i.e.*, all the true hexamerous Actiniæ, I have united in the family of the Liponemidæ. I shall discuss the others afterwards in the tribe of the Paractiniæ, as they are distinguished from the Liponemidæ by the principle of arrangement of the septa, and I attach more importance to this characteristic than even to the peculiar constitution of the tentacles.

If this retrograde formation of the tentacles is therefore to be regarded as a process which is carried on repeatedly and independently, the question may justly be raised if it would not be advisable to distribute the Actiniæ without tentacles among the other families. In this case the genus *Polysiphonia* ought to be placed among the Paractidæ, the genus *Polystomidium* among the Antheadæ, as the former has a mesodermal circular muscle, and the latter a weak endodermal circular muscle.

Polysiphonia. n. gen.

Liponemidæ with tentacles, transformed by retrograde formation into short tubes with wide terminal mouths; circular muscle mesodermal, slightly developed.

In the genus *Polysiphonia* we find the first stage of the retrograde formation of the tentacles; they have become short, stiff-walled tubes, which have only a weak set of muscles, are, at any rate, only capable of a small amount of contraction, and are therefore of no great value, either for groping about or for seizing upon prey. But as the terminal opening is very much enlarged and appears to remain permanently open, they have become inhaling tubes, through which the animal can draw in water and the nourishment suspended in it.

Polysiphonia tuberosa, n. sp. (Pl. II. figs. 7–9; Pl. VI. fig. 3; Pl. IX. figs. 1–10).

Body stiff and thick-walled, shaped like a stemless chalice, the surface beset with roundish knobs; oral disk, twelve lobed; tentacle tubes thickened to a swelling at the base, of different sizes, placed in two alternating rows; the larger tentacles correspond to the archings inwards, the smaller to the archings outwards of the oral disk.

Habitat.—Station 235. June 4, 1875. Lat. 34° 7′ N., long. 138° 0′ E. Depth, 565 fathoms. Twenty specimens.

Dimensions.—Diameter of the pedal disk, 3–4 cm.; diameter of the oral disk, 8–10 cm.; height, 5–8 cm.

Numerous specimens of a beautiful large Actinia, *Polysiphonia tuberosa*, were all dredged on the same spot from the bottom of the sea, at a depth of 565 fathoms. To judge from the nature of the material, part of them had been placed at once in spirit, part

previously treated with chromic acid. The former were unfortunately of absolutely no use, their tissues were macerated, and the form of the body disfigured by pressure almost past recognition, whilst the latter permitted a detailed description of the body form and of many anatomical conditions; the septa had, however, suffered severely in preservation, which, as I have noticed, is usually the case in material prepared by means of chromic acid.

Making allowance for changes caused by pressure, the form (Pl. II. fig. 7) is the same in all the specimens. The body begins with a relatively small, firmly attached base, rises to a considerable height, and gradually expands like a stemless chalice up to the oral disk, which unfolds like a flower. This form is rare among the Actiniæ, especially in contracted animals, since, on the other hand, the inversion of the margins of the oral disk usually causes the body to diminish in size upwards like a cone.

The ectodermal side of the pedal disk (Pl. IX. fig. 5) is covered with numerous (more than a hundred) radial ridges, which begin at the margin, and, partly at least, extend as far as the centre. They form a very dainty figure, as they have a vandyked, wavy course, and project with unusual sharpness above the level of the disk. On the endodermal side there are strong muscular cords, piercing the bases of the septa in bundles (fig. 4); they are crossed by other muscular cords, which pass transversely through the pedal disk from the endodermal to the ectodermal side. These perforating muscular fibres originate from the two muscular layers of the septa; this is best shown in transverse sections taken perpendicularly to the direction of the septa (fig. 1). Some of the longitudinal and of the transverse fibrillæ diverge and reach the mesoderm in bundles; their fibrillæ become intermixed, as they become interwoven with one another and with the layer of the basal circular muscles. The bundles then run towards the depressions which separate the ridges on the ectodermal side, and become fastened at the bottom of them; here they split up into the fibrillæ of which they are composed (fig. 7), so that their ends appear to be dendritically branched, and remind us of the ends of the muscular fibres of the Ctenophora.

As the perforating bundles originate from the muscles of the septa, it naturally follows that they are arranged regularly in radial rows. Each septum has two hardly separate corresponding rows, one of which is derived principally from the transverse muscles, the other principally from the longitudinal muscles. This is seen in the section which I have given in fig. 3, and which was taken parallel to the boundary surfaces of the pedal disk. As the section has fallen somewhat obliquely, we see at one end the bases of the septa cut through obliquely, then the circular muscles intersected by the bundles of perforating muscles, and, finally, the bundles running in two rows through the supporting substance.

Both the intersecting bundles of muscles and the depressions on the surface of the pedal disk (fig. 1) are wanting below the beginnings of young septa. This shows that the muscular layers of the septa only grow secondarily into the supporting substance, and that the depressions on the surface are occasioned by their becoming fastened to its ectodermal side.

The function of the muscular bundles is easily seen; they tend to raise the pedal disk at certain points from the underlying substance, and by thus forming a vacuum, cause the pedal disk to act like a sucker and secure the firm attachment of the animal.

The wall is 1 cm. thick, and is, moreover, remarkably firm, so that it furnishes a very effectual protection; it feels like cartilage or like the cellulose mantle of *Phallusia mammillata*, and, like the latter, easily separates into shreds on division. Under the microscope it shows a homogeneous fundamental substance in which fine filaments cross in all directions, and form a thickly tangled layer. Each filament runs separately, and can be followed some little way. From these the processes of the numerous minute cells are to be distinguished by their greater thickness and fine granulation.

The surface of the wall rises in numerous knobs 0·5 cm. across, which often have a small dark spot on the highest point; they are commonly arranged, though irregularly, in transverse and longitudinal rows. The wall feels otherwise quite smooth.

A special mesodermal circular muscle is present, even though in all the specimens the oral disk was widely extended, and the wall only slightly or not at all contracted. The circular muscle is of some breadth, as it measures nearly 2 cm., but its thickness can hardly be measured without the microscope; it lies close under the endoderm as a thin layer of bundles of muscular fibres (Pl. VI. fig. 3). If we consider that the body wall of the animal is not only very thick, but of cartilage-like consistency, we can easily understand that the contraction of the muscle is unable to effect rapid closure of the oral disk.

The bundles vary in strength, according as they consist of a smaller or greater number of fine muscular fibres; in their lower third they form a single layer, in which there is no perceptible further grouping; farther up, the bundles become arranged in rows, and then, as a larger quantity of connecting substance passes in between the rows, the latter radiate to the number of nine or ten into the gelatinous substance.

The wide oral disk, whose surface is covered with indistinct radial furrows, is not so strong as the wall, but, in comparison with other Actiniæ, equally rich in cartilage-like supporting substance. The radial muscles, whose bundles are compacted into a tolerably thick and firm layer, lie in the oral disk, separated from the ectoderm by a broad intermediate layer of supporting substance; some of the bundles become detached from the principal mass, and run through the fundamental connective tissue towards the endoderm, where they terminate. As they cross each other on the way they form an irregular network.

The tentacles are undeniably the most interesting portion of the oral disk, and their odd form attracts attention even on a superficial glance. They consist of two parts, a basal tuberous swelling, or bulb, and a hollow process, or tentacle tube (Pl. II. fig. 9; Pl. IX. figs. 8 and 9). The bulb is formed by a strong thickening of the supporting substance; and since this is most extensive on the peripheral side of the tentacle, the canal, which is not enlarged in other respects, runs eccentrically near the adaxial side.

Another consequence of this peripheral thickening is the eccentric position of the tentacle tube, which is thrust towards the adaxial side, where it rises in the form of a short process bent slightly outwards. It is furnished at the end with a wide opening, visible to the naked eye; its surface is wrinkled in consequence of muscular contraction, and its walls are brittle like those of other parts of the body.

The longitudinal bundles of the tentacles being prolongations of the radial muscles of the oral disk are likewise mesodermal, though forced apart and into an irregular course by the abundant connective substance (Pl. IX. fig. 2); it is only near the point of the tentacle that the muscular bundles are collected into a layer close under the endoderm (Pl. IX. fig. 6); they are consequently separated from their place of origin, the ectoderm, by a wider interspace than in any other Actinia. The bundles, which are still strong in the bulb, are, in the tentacle tubes, resolved by repeated division into very small groups of fibrillæ, if they have not ended previously as many of them do. In short, the tentacles are, both from the extreme weakness of their muscles and from the stiffness of their walls, very ill adapted for seizing upon prey, whilst, on the other hand, the wide lumen of the terminal opening indicates their function as inhalent canals and tubes. We have therefore plainly before us a process of transformation, which is further advanced in *Sicyonis* and still more so in *Polyopis* and *Polystomidium*, and which consists in the walls of the tentacle, its muscles, and its supporting lamella becoming reduced, whilst the terminal opening becomes widened. The tentacles are first transformed into tubes, and later into simple openings in the oral disk. As this is plainly the most important characteristic of our Actinia, I have named the animal *Polysiphonia* on account of the tubular nature of the tentacles.

The number of the tentacles amounts to nearly two hundred, perhaps to even more. They are distributed in two alternating rows, which do not, however, describe a simple circle, but are twelve times arched outwards at equal distances, so that the periphery of the oral disk becomes twelve lobed. At each of the twelve points which project inwards and separate the twelve lobes there is a remarkably large tentacle, which can easily be recognised by the thickness of its bulb; outside it, and belonging to the outer row, there are two equally large tentacles, whose bulbs are fused together; the other tentacles become smaller the further they lie right and left from these fused tentacles, so that the smallest are found on the outermost portions of the lobes.

The arrangement just described is still more plainly seen if we cut away the tentacles and their basal swellings by a horizontal section; this gives the figure shown in Plate II. fig. 8, in which the position of the tentacles is shown by the transected triangular canals. The mode in which the size of the tentacles gradually diminishes in the two alternating rows is very characteristic of *Polysiphonia tuberosa*, and distinguishes it from the majority of Actiniæ. In the Introduction I laid down the following rules:—(1) that the tentacles of one circle are commonly of the same size; (2) that the tentacles, if

they are not of the same size, become smaller in proportion as they belong to the more lately formed intraseptal spaces. Neither of these rules applies to *Polysiphonia tuberosa.* A glance at fig. 9 (Pl. II.) shows at once the differences which take place in one and the same circle, and if we go into the relations with the intraseptal spaces, we find that the twelve largest tentacles open into the twelve primary and secondary intraseptal spaces, whilst the smallest of all the tentacles belong to the twelve tertiary intraseptal spaces. In *Polysiphonia* the principle which regulates the size of the tentacles may be included in the proposition, that the tentacles become smaller the further they are removed from the twelve large tentacles of the first and second orders.

The œsophagus is tough and thick walled like the oral disk, whilst the septa are thin like veils; the œsophageal grooves and longitudinal furrows require no special description. Of the forty-eight pairs of septa twenty-four are perfect, but the state of preservation of all the internal organs of the species was such that I can say nothing as to the structure and arrangement of the reproductive organs.

Polystomidium, n. gen.

Liponemidæ, with longitudinal furrows and marginal spherules on the wall; tentacles transformed by retrograde formation into stomidia; circular muscle endodermal.

In the *Polystomidia*, the tentacles have undergone retrograde formation to an extent which has hitherto been observed only in the genus *Polyopis;* the only traces of them are the terminal openings, which lead directly into the radial chambers and are surrounded by swollen margins, the remains of the tentacle wall. In their habit of body, in the endodermal position of the circular muscle, and in the presence of the marginal spherules, these animals are allied to the Antheadæ.

Polystomidium patens, n. sp. (Pl. V.).

Body dish-shaped, widening from the small pedal disk to the wide oral disk; stomidia in two alternating rows.

Habitat.—Station 296. November 9, 1875. Lat. 38° 6′ S., long. 88° 2′ W. Depth, 1825 fathoms. One specimen.

Dimensions.—Diameter of the oral disk, 6 cm.; diameter of the pedal disk, 1·5 cm.; height of the wall, 2·7 cm.

Colour.—(Determined from the spirit specimen) brownish-grey, the endodermal parts brown-violet, except the filaments which were coloured white.

Of this interesting deep-sea Actinia, which I have placed here under the name *Polystomidium patens* as the representative of a new genus and new species, I had unfortunately only one specimen at my disposal, and it had been so severely injured in being dredged from the depth of 1825 fathoms, that it was in a condition but little adapted for minute examination. The body was flattened into a cake, of which one side was com-

pletely covered with parts of the thin-membraned lamellæ of the septa, hanging in tatters, and with the reproductive organs and mesenteric filaments. The latter protruded partly from the œsophagus, partly from rents and fissures in the oral disk and wall, and partly from the openings, which replace the tentacles and represent them morphologically.

After the tattered fragments had been partially removed, it was found that one side of the Actinia was formed by the œsophagus and oral disk, the other by the wall and the pedal disk (fig. 3). The pedal disk is only slightly distinguished from the wall as a shallow depression 1·5 cm. in diameter, the bottom of which forms a convex projection into the interior of the gastric space of the Actinia. The wall, which is about 2·7 cm. long, shows distinct longitudinal furrows, which run from the margin of the pedal disk to the margin of the oral disk, and indicate externally the origins of the septa. As they amount to more than seventy in number, they correspond to thirty-six pairs of septa, which were also visible on dissection. Small knobs, which may perhaps be compared to the "bourses marginales" of other Actiniæ, lie one in each of the interspaces between these longitudinal lines, at a little distance from the margin of the oral disk. The surface of the wall is otherwise quite smooth.

The endodermal circular layer of fibres is pleated as far as the wall extends, and rises in muscular folds, which usually remain simple or are only slightly branched (fig. 10). The folds are more extensively branched only in the uppermost section of the body, where they form a sphincter which lies between the marginal spherules and the corona of stomidia, somewhat below the latter, and causes the wall to project outwardly (fig. 8). A longitudinal section through the wall, therefore, shows us two evaginations lying at the upper end, the one above the other, in which the supporting lamella becomes very much thinner. The lower one is caused by the marginal spherule, the upper by the circular muscle; the former contains a hollow space and is lined by a weak muscular layer, the interior of the latter is almost completely filled by the deep muscular folds, whose arrangement is more minutely given in fig. 9. The ramification of the separate folds decreases both above and below, so that the circular muscle is gradually transformed into the usual muscular layer.

The entire absence of the tentacles is a striking feature of the oral disk; they are replaced by openings like buttonholes (fig. 6), which I shall term "stomidia," and on account of which I have named the genus *Polystomidium*. Their exact number could not be directly determined, as the oral disk was greatly injured in many places, but, bearing in mind their relation to the septa, it may be estimated at about seventy-two. In dissecting the septa we find that one stomidium opens into each radial chamber. The stomidia belonging to the intraseptal spaces are usually smaller, and form an inner circle by themselves; the stomidia of the interseptal spaces alternate with them, and are placed in an outer circle; their longitudinal diameter runs in a radial direction, and amounts to about 0·5 cm.

The constitution of the margins is the standard by which I have determined that the stomidia may be normal phenomena and not merely rents in the oral disk. The outer stomidia leading into the interseptal spaces are separated from one another by narrow ridges, which have arisen from the septa belonging to a pair converging upwards and becoming directly united. The roof of an intraseptal space furnished by the oral disk, which is usually of considerable breadth, has consequently undergone almost complete retrograde formation. Towards the oral opening the stomidia are surrounded by swollen lips, folded like frills; these are still more perceptible on the inner stomidia, round which they form a border.

As the arrangement of the stomidia follows that of the tentacles in other Actiniæ, there seems no doubt that they represent the latter morphologically. I have already shown in the Introduction that they may be derived in the most simple way from the tentacles if we assume that the wall of the tentacle has become contracted into the encircling lip-swelling, whilst the terminal opening has become proportionably widened.

The oral disk is thickly pleated inwards from the stomidia, and covered with radial swellings, which lie between the insertions of the septa and gradually disappear towards the oral opening. The radial muscular fibres do not pass into the mesoderm, but remain in the ectoderm; like all muscular fibres of *Polystomidium*, they are very powerful, and are united into a thickly-pleated lamella. The muscular folds are specially high in the peripheral parts of the oral disk, where they lie thickly compacted and repeatedly branched (figs. 4 and 7).

On the œsophagus there is a remarkable circular fold, which runs at a little distance below the labial margin, and marks off in this way a small upper section of the œsophagus. Openings, equal in number to the stomidia on the oral disk, lie in this section, and lead directly into the radial chambers (fig. 1). I have only observed similar formations in *Polyopis striata*, another Actinia in which the tentacles have undergone retrograde formation. The lower section of the œsophagus is covered with numerous longitudinal furrows. Besides these there are two well-marked œsophageal grooves, and two long œsophageal lappets, by which the directive septa can be easily determined.

The number of the septa is smaller than in most of the larger Actiniæ. Calculating the number in the entire animal from the quadrant in which I dissected the septa, and from the longitudinal lines on the surface of the body, there are altogether thirty-six pairs of septa; six pairs of principal septa of the first order, six pairs of the second order, and twenty-four pairs of the third. The last number is very remarkable, as there are usually only twelve pairs of septa of the third order. In consequence of this the interseptal spaces of the second order are divided, not as usual into two, but into three interspaces, because of the duplication of the septa of the third order. In this way *Polystomidium patens* shows a variation from the regular conditions of the hexamerous Actiniæ.

The muscular part of the septa is very thick and powerful, and uniformly strong

throughout; their longitudinal muscular fibres are developed into a repeatedly folded muscular lamella, whilst their transverse fibres are weak. The parietobasilar muscle, which springs from the small pedal disk, and reaches half-way up the wall, is also weak (fig. 2).

The greater part of the thin-membraned portions of the septa had been torn away; where they still remained they lay in the interseptal and intraseptal chambers, from which they protruded through the stomidia. They contained the reproductive organs, the specimen examined by me being a male. The follicles, filled with spermatoblasts and spermatozoa, are not so thickly compacted as in most other Actiniæ, but rather isolated and of considerable size, so that they can be separately recognised with the naked eye placed beside one another like paving-stones.

All the septa reach the œsophagus; the upper part only of the forty-eight septa of the third order is connected with the œsophagus, whilst the others extend much farther downwards; they are all pierced by peristomial openings, forming a circular canal in the aggregate. The only difference between the septa—apart from size—seems to be that the principal septa are without reproductive organs. I must, however, remark that in consequence of the numerous injuries, it is impossible to make any positive statements as to the distribution of the reproductive elements upon the septa.

All the surfaces of the wall and of the septa covered with endoderm are brownish-violet, as numerous pigment granules are deposited in the epithelium. The mesenteric filaments, which I have figured in transverse section in fig. 5, form the only exception; they are whitish like the ectodermal parts, and are distinguished in this way from the dark ground of the septa on which they run in numerous meandrous curves.

Family, Sagartidæ, Gosse.

Sagartinæ = Phellinæ, Verrill.

Hexactiniæ with acontia, a strong mesodermal circular muscle and numerous very contractile tentacles; the principal septa, or septa of the first order, only are perfect and at the same time sterile; all the remaining septa are imperfect.

In my researches on the Actiniæ, which have already extended over a very large amount of material, I have almost always found two characters combined. (1) The presence of filaments known as acontia near the lower end of the mesenteric filaments; they float freely in the gastric cavity, are thickly covered with nematocysts, and if danger threatens can be protruded quickly as weapons of defence. (2) The six pairs of principal septa only reach the œsophagus, all the others being imperfect. Reproductive organs are found only on the secondary septa, of which, however, the older are often permanently sterile.

My brother and I first observed these facts in *Adamsia diaphana, Metridium dianthus,*

and *Calliactis* (*Sagartia*) *parasitica;* I have been able to corroborate them in five different species of the Challenger material, and found, moreover, that in no instance, where the acontia were present, was the differentiation of the septa wanting, and that the Amphianthidæ were the only Actiniæ in which the acontia were absent, though the septa showed the Sagartid type. I therefore feel justified in making use of both characters to limit a family of Actiniæ, which I still term Sagartidæ, as most of the forms belonging to it have been determined as such by former authors.

A third characteristic is common to all Sagartidæ, viz., the presence of a strong mesodermal circular muscle, but this is only of subordinate value, as it occurs in other families.

Nearly all the descriptions published of the *Sagartiæ* and the closely allied forms are unfortunately so imperfect that it is impossible to determine how far the forms hitherto described come under the above diagnosis. As yet, we can only assume this to be definitely the case in *Sagartia schilleriana*, discovered by Stoliczka (Journ. Asiat. Soc. Bengal, vol. xxxviii. part ii. p. 28–63, 1869). Another form, *Sagartia troglodytes*, may, on the other hand, be considered as an exception; v. Heider states (Sitzungsber. der Wiener Akad., Math. Naturw. Cl., Bd. lxxv. Abth. 1, p. 367, 1877) that in it forty-eight pairs of septa reach the œsophagus, and at the same time describes formations in it, which undeniably are acontia, though the author does not distinguish them from the mesenteric filaments. However, as I have already specially remarked, I am doubtful whether v. Heider has not confused sections through the oral disk with sections through the œsophagus, and consequently over-estimated the number of the perfect septa. Such a mistake might easily occur in highly contracted animals like those which he examined.

As far as we can judge at present, the family of the Sagartidæ, as I have now defined it, would coincide on the whole with Gosse's Sagartidæ. The most essential difference is that I have included the genus *Bunodes* in it. In so doing I relied upon the examination of a single species, which showed externally the arrangement of papillæ characteristic of the *Bunodes*, but which must be placed among the Sagartidæ, from its anatomical constitution. It remains for future observers to determine whether the structure is the same in the other species as in our *Bunodes minuta;* at present it is quite possible that perfectly heterogeneous species have been included under the same generic name. It must, however, be borne in mind that Verrill (Transact. Connect. Acad., vol. i. p. 467) and Jourdan do not attribute any acontia to the genus *Bunodes*, and Gosse (Actinologia Britannica, p. 204) only to a single species.

Verrill has separated the sub-family of the Phellinæ from the Sagartidæ, an innovation of which I do not approve, as there are transition forms between *Sagartia* and *Phellia*. The cuticular secretion, the "epidermis" of the said authors, which covers the wall of *Phellia* as far as a ring close under the tentacles, is present, though less highly

developed, in *Cereus spinosus*, but is not so sharply confined to definite parts as in *Phellia*.

After what has been said in the preface, no further explanation is required as to my reasons for omitting the cinclides in the general character of the family. I shall henceforward mention the cinclides only in cases where they can be observed anatomically by transverse and horizontal sections, or by observation with the naked eye. This is possible in a number of species belonging to the genus *Calliactis*. In *Calliactis parasitica* there are openings at certain points, having swollen margins, which project somewhat above the surface of the wall; they can be easily observed even in the dead animal, but they are so distinct in the living Calliactis that they have been already described and figured by earlier naturalists, such as Forskål (Descriptiones animalium, &c., 1775), Ehrenberg, and Dana. This is not the case in the majority of the Sagartidæ.

Sagartia, Gosse, *pro parte*.

Sagartia, Verrill.

Sagartidæ with smooth wall and numerous powerful tentacles arranged in several rows; with circular oral disk; without anatomically perceptible cinclides.

Though I agree as far as possible with Verrill in the limitation of the genera, I restrict the genus *Sagartia* to forms in which it can be shown at most that the acontia pass out through the wall, but in which, however, no openings can be pointed out, either because they are not preformed or because they are so small and indistinct as to be easily overlooked even with most careful observation. The genus *Sagartia* is distinguished in this point from *Calliactis*; it is, moreover, distinguished from *Cereus*, *Bunodes*, and *Phellia* by the smooth nature of the wall, arising from the absence of papillæ and cuticular excretions, and finally from *Metridium* by the circular shape of the oral disk, and by the powerful development of the tentacles.

Sagartia, sp. ?

Body flattened like a cake in the contracted condition; tentacles nearly two hundred in number, placed in five rows, and decreasing in size from within outwards; muscles of the tentacles and of the oral disk ectodermal, hardly at all pleated.

Habitat.—Station 194. September 29, 1874. Lat. 4° 33′ S., long. 129° 58′ E. Depth, 360 fathoms. One specimen.

Dimensions.—Diameter of the pedal disk, 4 cm.

Colour.—(Determined from the spirit specimen) whitish on the whole, the middle third of the wall yellowish-red.

There was only a single specimen of a true *Sagartia* in the Challenger material. It was attached to a very porous stone of volcanic origin, but it was so strongly contracted,

and its external appearance presented so little that was characteristic, that I gave up the idea of determining the species more closely, and only decided to give a description of it in order that the important genus might not be left unrepresented.

The animal was so strongly contracted that its body formed a cone, nearly flattened into a disk, the base of which measured 4 cm., whilst its height measured little more than 0·5 cm. The surface of the animal is extremely smooth; it is whitish at the base, then assumes a yellowish-reddish colour, which again passes gradually into white. The coloured part appears longitudinally striated, because the red and yellow alternately predominate in the ground-tint.

The wall is on the whole thin-membraned, and becomes about six times as thick only at the upper margin. This very unusual increase in bulk is explained partly by the high degree of contraction, partly by the great strength of the mesodermal circular muscle. The latter occupies nearly the entire thickness of the wall, and is only separated from the ectoderm by a very thin layer of connective substance, whilst a rather broader layer separates it from the endoderm. Its contour corresponds to the form of the wall, so that it is broad above and drawn out to a point below. We rarely find such beautiful primitive bundles in transverse section as in our *Sagartia;* they are formed of strong fibrillæ, are regularly oval or rounded circularly, and of medium size. On the other hand, the way in which they run is remarkably irregular. In the same transverse section we find, side by side, bundles, some divided obliquely, and others divided perpendicularly, and we see in the thicker parts of the section how the bundles cross and become interwoven in their course.

Contrasted with the circular muscle, the radial muscular fibres of the oral disk and of the tentacles are only slightly developed, and form a very slightly pleated layer in the ectoderm. The tentacles are limited to the periphery of the oral disk, where they are arranged in five rows, and decrease a little in size from within outwards. They are of medium length, rather slender, and pointed at the end. I counted twenty-five in about an eighth of the animal, so that there are probably one hundred and ninety-six in all.

From transverse sections taken through the œsophagus I estimated the number of septa at forty-eight pairs, of which the six principal pairs only are perfect. There would probably be a much larger number at the base, as small septa reaching only a little way project there, in the angle between the pedal disk and the wall. There were reproductive organs (mature testes) on all the larger secondary septa. Finally, in transverse section, I could perceive wide openings in the septa near the wall.

Calliactis, Verrill.

Sagartidæ with smooth wall and numerous tentacles, with distinct cinclides which pierce the wall not far from the base in one or several transverse rows.

Following Verrill's example (Trans. Connect. Acad., vol. i. p. 481), I have separated the genus *Calliactis* from *Sagartia*, as in it we find distinct cinclides constantly present in a circle above the base. They are easily made out in a fresh state, and often after treatment with reagents as warts, into which a small evagination protrudes from the gastric space, so that the membrane of the wall becomes much thinned away; an opening, which it is more difficult to find, lies in the middle of the knob. If the knobs do not project sufficiently above the surface, it is merely necessary to remove the uppermost layer of the wall by means of a section parallel to the surface in order to make the cinclides which traverse the thickness of the supporting substance distinctly visible; this method answers very well, if we wish to determine the number of cinclides in preserved specimens of *Calliactis*.

The forms belonging to this genus agree so far in their manner of life that they are only found upon Gasteropod shells, the interior of which is occupied by a *Pagurus*. Their best known representative is *Calliactis* (*Sagartia*) *parasitica*, in which my brother and I have made out and described the cinclides; other forms are *Calliactis polypus*, *Calliactis decorata*, and *Calliactis variegata*. All these species are difficult to distinguish in a preserved state, as the colour has usually formed an important point in their definition. The forms of *Calliactis* in the Challenger material appear to me identical with *Calliactis polypus*; none of them belong to *Calliactis parasitica*.

Calliactis polypus.

Priapus polypus, Forskål, Descriptiones animalium, p. 102, tab. xxvii. fig. C, 1775.
Cribrina polypus, Ehrenberg, Corallen. d. roth. Meeres, p. 40, 1834.
Adamsia priapus, Milne-Edwards, Hist. des Corall., tom. i. p. 280, 1857.
Calliactis polypus, Klunzinger, Korall. d. roth. Meeres, i. p. 76, taf. v. fig. 1, 1877.

Wall smooth, with a circle of 24 cinclides; tentacles long and slender, above 600 in number, placed in numerous circles, decreasing in size from within outwards; twelve tentacles in the innermost circle, twelve in the next, twenty-four in the third, and so on.

Habitat.—(*a*) Station 208. January 17, 1875. Lat. 11° 37′ N., long. 123° 32′ E. Depth, 18 fathoms. Three specimens on one Gasteropod shell. (*b*) St. Vincent, Cape Verde Islands. Six specimens on one Gasteropod shell.

Dimensions.—Breadth of pedal disk up to 4 cm.; height up to 3 cm.

The specimens of *Calliactis polypus*, taken at two different places, lay, in the one case, in a group of six individuals on the shell of a *Natica*, and in the other in a group of three on the shell of a *Murex*. They were, however, all contracted into a shallow conical mass, at the point of which the tentacles appeared here and there, as Klunzinger has already described in this Actinia.

The pedal disk is very large, and firmly fastened to the shell by means of a brownish mass. The wall is smooth, and only folded longitudinally above in consequence of contraction; it is tough and opaque except in a small portion adjoining the pedal disk,

which is thin as paper, and through which the insertions of more than one hundred and fifty septa are visible. The cinclides form a single circle at a little distance from the pedal disk; they are placed irregularly, sometimes higher, sometimes lower and closer to the disk. Their walls rise above the surface in places like an hour-glass; where this is not the case they cannot be seen from the surface, and only become visible after the superficial layer of the wall has been removed by a section parallel to the surface in the manner already specified. Their number seemed to amount invariably to twenty-four; they open into the intraseptal spaces of the first three orders of septa.

The circular muscle at the upper end traverses the entire mass of the wall, which is trebly thickened at this point, but is separated from the endoderm by a narrow layer of connective substance, from the ectoderm by a rather broader layer of connective substance; it is most powerful in the middle, and becomes weaker above and below; above, it reaches as far as the origin of the oral disk, where at the same time it most closely approaches the two layers of epithelium.

The bundles of muscular fibrillæ show a tendency to arrangement in parallel layers, placed one above the other as in *Phellia pectinata* (Pl. VI. fig. 5) and *Cereus spinosus* (Pl. VI. fig. 1), though not so distinctly as in the latter species. Each layer again consists of a number of smaller and larger groups of bundles of fibrillæ, placed in a line one behind the other, and each bundle, in transverse section, is divided by constrictions of its surface into lobes which are sometimes more, sometimes less distinctly separated from one another. The muscular fibres which occupy the periphery and enclose the protoplasmic axis in an undulating layer, are of medium strength.

The arrangement of the bundles of fibrillæ in layers becomes less distinct above and below; above, because the bundles are so pressed together that only a scanty framework of the separating connective tissue trabeculæ remains; and below, because, on the other hand, the bundles become very small and are isolated from one another. Finally, the bundles of fibrillæ become flatter from the outside towards the inside, but this is merely in consequence of the contraction of the animal.

The circular muscle of *Calliactis polypus* described above, is chiefly distinguished from the circular muscle of *Calliactis parasitica*, which we have already investigated (Actinien, p. 180), by not being divided into two distinct parts. There are also differences in the muscular system, which enable us to distinguish the two species in a preserved condition. I refer to the radial muscles of the oral disk, and to the similarly constructed longitudinal muscles of the tentacles.

The radial muscular fibres in *Calliactis polypus* form a thick layer which is always thinned away above the insertions of the larger septa, and so divided into broader and narrower radial bands. Their figure in transverse section is difficult to make out; at first sight it gives the impression that masses of compacted muscular fibres, placed in repeated layers the one above the other, have been deposited between the

supporting lamella and the layer of nerve fibres of the ectoderm. It is necessary to employ a staining fluid (picro-carmine), which impregnates the supporting substance strongly, in order to distinguish a framework of connective tissue between the muscular fibres; and as this gives rise to extremely fine-walled meshes, it divides the muscular fibres into mesodermal bundles of fibrillæ. Numerous supporting layers run out from the surfaces of the supporting lamellæ, and these ramify and anastomose with one another. The anastomoses are wanting towards the ectoderm, so that the meshes open towards the layer of nerve fibres; the muscles are consequently partly mesodermal, partly ectodermal.

In *Calliactis parasitica* the boundary line between the mesodermal muscles and the ectoderm is also indistinct, but the bulk of the former is much smaller, so that sparse bundles only are enclosed in an abundant fundamental substance.

The tentacles of *Calliactis polypus* are long, slender, and end in a fine point. I made out about seventy in a twelfth part of the animal, so that altogether they amount in number to several hundreds, which decrease in size from within outwards, and are arranged in about ten circles. The first and second circles, beginning at the inside, each contain twelve tentacles placed somewhat apart, the third twenty-four tentacles, the fourth forty-eight, and so on.

If we take the well-developed septa only into consideration, there are altogether our cycles or forty-eight pairs, the first six pairs of which are perfect. The following six pairs are imperfect and sterile like the first six, so that the reproductive organs are confined to the septa of the third and fourth orders. The specimen examined by me was a male, and contained ripe testes.

Cereus, Oken.

Sagartidæ, with numerous tentacles and circular oral disk, without cinclides which can be anatomically demonstrated; wall rough, and covered with knobs.

Milne-Edwards (Hist. des Corall., tom. i. p. 263) included all the more typical representatives of his "Actinines verruqueuses" in Oken's genus *Cereus*. After it had been shown that acontia existed in *Cereus bellis*, which had been taken by Oken as the typical representative of the genus (Lehrbuch d. Naturgeschichte, Th. III. Abth. 1, p. 349, 1815), Verrill limited the name to forms of the family Sagartidæ. I agree with Verrill on this point, but wish to attach more importance in the diagnosis to the papillose nature of the wall, in order to establish a sharp distinction between this genus and *Sagartia*. I have therefore altered the description of the wall, which runs thus in Verrill: "upper part with small, inconspicuous contractile suckers; walls nearly smooth."

Cereus spinosus, n. sp. (Pl. I. figs. 3–5; Pl. VI. fig. 1; Pl. VIII. fig. 6; Pl. XII. fig. 10).

Papillæ of the wall unequal in size, with a tendency to arrangement in transverse and longitudinal rows; each papilla runs out into a fine point, which is placed on a hemi-

spheroidal base; surface of the wall rough and bark-like; tentacles tolerably long, placed in three rows decreasing in size from within outwards.

Habitat.—(*a*) Station 157. March 3, 1874. Lat. 53° 55′ S., long. 108° 35′ E. Depth, 1950 fathoms. One specimen. (*b*) Station 237. June 17, 1875. Lat. 34° 37′ N., long. 140° 32′ E. Depth, 1875 fathoms. Four specimens.

Dimensions.—Diameter of the pedal disk, 5 cm.; height, 7 cm.

Colour.—(Determined from the spirit specimen) a dirty violet.

The new species, which I have named *Cereus spinosus*, was found at two different places. The first time there were several specimens, which were unfortunately preserved in chromic acid, and thus rendered of no practical use. The second time there was only a single specimen, which was very well preserved in spirit, and from which the following description is exclusively taken.

The colour of the body was a dirty violet in all parts to which the spirit had easy access, whilst in other parts it had become discoloured into a greyish-yellow. For example, the outer tentacles were violet, and so were the points of the inner tentacles, whilst the bases of the latter were yellowish. This was caused from the animal being in a semi-contracted condition, in which portions of the tentacles project freely.

It was plain that the pedal disk had been attached to a very narrow underlying substance, and had consequently acquired a very irregular shape. Part of the disk surrounded the stalk of a *Hyalonema*, which was consequently enclosed in a canal, so that the edges of the disk are not only placed firmly one against the other, but have actually become fused. The pedal disk is otherwise opaque, tough, and knobbed, and thus presents a bark-like appearance.

The surface of the wall is likewise very rough. Its lower third is covered with circular furrows, which are placed at a little distance from one another, and run parallel to the margin of the pedal disk. At the upper end the furrows lie further apart and become irregular, whilst at the same time they are crossed here and there by longitudinal furrows. The numerous knobs with their pointed ends, on account of which I have named the species *Cereus spinosus*, deserve special attention; they show a tendency to arrangement in transverse and longitudinal lines, but are wanting in some places, whilst they are thickly compacted in others. In the upper third of the wall they are of considerable size, begin with a broad hemispheroidal base and end in a thorn-like point, marked off by its dark brown colour from its surroundings. Lower down the knobs become smaller, and are finally merely minute pointed knobs, which are very firm, and coloured an intense brown.

The bark-like appearance of the pedal disk and wall is owing to a cuticular deposit (the "epidermis" of former authors), in which we can distinguish two layers (Pl. VIII. fig. 6). The surface of the epithelium is covered first of all by a yellowish, irregularly fibrous border, which is torn in some places, and raised here and there in tube-shaped processes, of which one is shown in fig. 6, *b*. Outside the fibrous border comes a granular

mass traversed by foreign bodies. The epithelium lying below this deposit is without cilia, and varies very much in height; the epithelial stratum sometimes shrinks to an almost invisible layer, and sometimes rises into long, filamentous cylindrical cells.

The wall in *Cereus spinosus* is very thick (as much as 3 mm. in transverse section), tough, and leathery as in the majority of Sagartidæ. It is constricted at the upper end by a circular muscle, which, in spite of its strength, is entirely concealed in the mesoderm of the wall. The muscle is nearly 1·5 cm. long and nearly 2 mm. broad in section at its upper end, whilst it becomes narrow below as usual. It is separated both from the ectoderm and the endoderm by a layer of connective tissue, 0·5 mm. broad, and without muscles. Seen in transverse section (Pl. VI. fig. 1), the muscular fibrillæ in the upper half of the muscle form rows rising from within and below, obliquely upwards and outwards; they are separated by broad bands of connective tissue, and placed in tiers one above the other. Here and there a row consists of a single flattened primitive bundle, the indentations of whose surface indicate its tendency to split up into a series of smaller bundles. This process has, however, usually taken place, so that each single tier is composed of a series of smaller roundish bundles and larger flattened bundles. Two successive tiers of bundles are not completely separated, but connected by a network of thin branched anastomosing cords; the bundles of each tier are connected with one another in the same way. The former is visible in sections taken parallel to the surface of the wall, the latter in sections parallel to the base of the animal.

The character of the muscle changes in the lower half as the bundles of fibrillæ are scattered at considerable distances from one another. The larger bundles are lobed in transverse section, or resolved into a group of smaller bundles of fibrillæ.

The radial striation is distinctly marked on the oral disk, and is caused by the manner in which the muscles are arranged, while this again is correlated with the distribution of the tentacles. The radial muscular layer is ectodermal and pleated very uniformly, so that the single folds of muscles are only slightly branched, and lie beside one another like the leaves of a book. Besides this uniform pleating, the enlargement of the muscular layer is due to the fact that the supporting layer is thinner at the insertions of the septa, but becomes thickened above the middle of each interseptal space, where it forms a sharp, roof-like ridge. The ridges formed in this way produce the radial striation of the oral disk already mentioned; seen from the surface, they do not project very sharply so long as they are covered by epithelium, which in a measure reduces their inequalities. The ridges begin near the margin of the mouth (Pl. I. figs. 4 and 5); they are forty-eight in number, twenty-four corresponding to the intraseptal spaces of the first, second, and third orders, and the other twenty-four to the intermediate interseptal spaces. The first twenty-four are broadest near the margin of the mouth, become narrower towards the periphery, and end on the twenty-four tentacles of the innermost row, where they run a little way divided into two by a shallow furrow. The second twenty-four ridges differ,

inasmuch as they are broadest towards the periphery, where they are each divided by two long radial furrows into three ridges, a middle ridge belonging to one of the twenty-four tentacles of the second cycle, and two lateral ridges which pass on to two of the forty-eight tentacles of the third cycle. This division corresponds at the same time to the arrangement of the septa, the twenty-four interseptal spaces are divided in the periphery by the twenty-four pairs of septa of the fourth order into three compartments, an intraspace and two interspaces.

The number and mode of arrangement of the tentacles may be deduced from what has been said. We find altogether ninety-six tentacles distributed in three rows, twenty-four in the first or innermost row, twenty-four alternating with them in the second row, and forty-eight in the third row. This is best seen if we cut away the tentacles, leaving only the short basal stumps (Pl. I. fig. 4). The tentacles have a slender shape, diminishing uniformly from the base towards the point; they are distinctly striated longitudinally and perforated at the end by a fine opening; they are largest in the innermost row, where they attain a length of 2 cm. The longitudinal striation is caused by elevations of the supporting lamella, which are covered moreover with small folds bearing the muscles.

The boundary between the oral disk and the œsophagus is only indicated by a slightly swollen lip. The œsophagus has tolerably broad œsophageal grooves and short œsophageal lappets; it also shows eleven powerful longitudinal swellings on either side (fig. 5).

The arrangement of the septa is governed by the same principle, which has been already laid down as applicable to most *Sagartiæ*. Its characteristic is, that only the six pairs of principal septa, of which again two pairs are directive septa, reach the œsophagus. The principal septa are, at the same time, exclusively muscular septa, *i.e.*, they do not develop reproductive organs. Their muscular systems are not very strong; for example, the parietobasilar muscle is merely a slight fold; the most distinct among them are the longitudinal fibres, which rise obliquely from the wall and the base to the oral disk. An internal septal stoma is certainly present, but so small as to be easily overlooked; an external septal stoma is wanting.

The principal septa are followed by three cycles of imperfect septa; the development of their muscular system is far behind that of the principal septa, but, on the other hand, they are furnished with reproductive organs (in the present case with ovaries). In each cycle they become smaller, and project less into the gastric space and towards the pedal disk and oral disk. The last forty-eight pairs are hardly recognisable as longitudinal lines on the wall, and merely project as folds in the angles formed by the wall on one side and the oral disk or pedal disk on the other (figs. 4 and 5, h^4). The reproductive organs lie highest up, and quite hidden by the œsophagus on the septa of the second order (figs. 4 and 5, h^2); in the septa of the third order they are visible under the lower margin of the œsophagus (figs. 4 and 5, h^3), while in the septa of the fourth order they are insignificant bodies, confined to the lowest section.

The free margin of each septum is occupied by the mesenteric filament. The upper section is tripartite, the lateral ciliated streaks still lying beside the median glandular streak, whilst the lower section is simple, and formed merely of the glandular streak. This last comports itself differently on the different septa; in the septa of the first and second orders it is disposed in meandrous curves and coiled into a thick mass, which, in the septa of the first order, is visible beneath the margin of the œsophagus, whilst it is covered by the latter in the septa of the second order; in the other septa it appears as a slightly waved border. The acontia common to all *Sagartiæ*, and of which one at least is found in each septum—even in the small septa of the fourth order—arise at a little distance from the lower end of the mesenteric filaments. In transverse section the acontium shows a roundish figure flattened somewhat to an oblong (Pl. XII. fig. 10). On one of the longer sides there is an indentation, the expression of a groove which runs on the acontium as far as its point of attachment to the septum. Histologically we can distinguish an axis of connective tissue and a cylindrical epithelium, containing numerous nematocysts, especially on the side of the acontium remote from the groove. In *Calliactis parasitica*, we had previously distinguished fine muscular fibres and a layer of nerve fibres; these doubtless exist in *Cereus spinosus*, but the specimen was not well enough preserved to admit of their being made out plainly.

If we open a *Cereus spinosus* by a longitudinal incision we can distinguish the different pairs of septa, without further dissection, by the constitution of the reproductive organs and of the mesenteric filaments (fig. 5). The pairs of septa of the first order (h^1) are recognisable by the thick coils of mesenteric filaments, which spring from them below the œsophagus, whilst the pairs of septa of the second order (h^2), the reproductive organs and mesenteric filaments of which are usually completely covered by the œsophagus, appear only as sharply defined lamellæ with smooth margins; in the septa of the third order (h^3), in which the coils of filaments are wanting, the ends of the reproductive organs project from beneath the lower margin of the œsophagus, whilst the pairs of septa of the fourth order are so small as to be quite out of sight.

Phellia, Gosse.

Sagartidæ with a rough, cuticular sheath, which is firmly attached to the epithelium, and leaves the upper part of the wall free; the latter is smooth and becomes inverted during contraction; cinclides not demonstrable anatomically; tentacles small, and few in number.

The cuticular sheath, which we have already found in *Cereus spinosus*, is still more strongly developed in a number of Actiniæ, but is here confined at the same time to one part of the wall, leaving the other part free. Close underneath the corona of tentacles, the free part of the wall forms a broader or narrower ring,

which is soft-membraned and smooth walled, is pretty sharply defined from the bark-like section of the wall, and, like the oral disk, is inverted during contraction. Gosse formed the genus *Phellia* for these Actiniæ, which are easily recognised even by a superficial observer (Ann. and Mag. of Nat. Hist., ser. iii. vol. ii. p. 192); Verrill went a step further, and erected them into a special sub-family, though in so doing he attached undue value to the character.

Jourdan was the first to explain the essential nature of this formation by pointing out that the bark-like layer is merely a deposit on the ectodermal epithelium, and that the latter has undergone retrograde formation under this deposit so as to become an imperceptible layer (Annales des Sciences Nat. Zool., ser. vi. t. x. p. 98).

Verrill has made some statements about the internal structure of the *Phelliæ* (Transact. Connect. Acad., vol. i. p. 490), which refer to *Phellia panamensis;* the ovaries are irregularly distributed on the septa, are wanting on the smaller, and present only on the twelve largest. This so flatly contradicts all observations on the distribution of the reproductive elements in the Actiniæ, that Verrill must somehow have been mistaken. His observations are of no use for another reason, namely, that he says nothing about the relation of the septa to the œsophagus.

Phellia pectinata, n. sp. (Pl. I. fig. 7; Pl. VI. fig. 5; Pl. VIII. figs. 1, 2, and 10).

The bark-like part of the wall is covered with transverse and longitudinal furrows; terminating above in twelve knobs, which are prolonged on to the inverted soft-membraned section as twelve longitudinal combs; each comb ends in a very prominent, bifurcated, nose-like projection; tentacles small, pointed, arranged in four cycles.

Habitat.—Station 307. January 4, 1876. Lat. 49° 24′ S., long. 74° 23′ W. Depth, 147 fathoms. One specimen.

Dimensions.—Height of the wall (taken as far as the inverted soft-membraned part), 2 cm.; breadth, 1·5 cm.

This animal, which I have incorporated as a new species in the genus *Phellia*, would hardly be taken for an Actinia by any one who glanced at it in a contracted condition; its small body, about 2 cm. high and 1·5 cm. broad, rather resembles the body of a *Cynthia*, perhaps *Cynthia canopus;* it has the same rough, somewhat shaggy surface, the same leather-like consistency, the same oval form having an opening at the one end, whilst a second opening similar to the egestive opening is naturally wanting. This constitution of body is explained by the peculiar fashion in which the animal contracts itself; during this process not only the oral disk and corona of tentacles, but the upper part of the wall is so deeply invaginated that not the smallest part of the tentacles nor of the oral disk remains externally visible.

As in every *Phellia* we can distinguish two sections in the wall, a lower section which does not, and an upper part which does, become invaginated. The two

parts are very differently constituted. The former, which is the only part externally visible, is covered with transverse wrinkles, crossed here and there with longitudinal furrows. It terminates above in twelve knobs which are placed like a corona round the entrance to the orifice of invagination, and lie close together so as to greatly contract the opening.

In order to understand the construction of the upper part, it is necessary to open up the animal longitudinally, then we see that it extends about 1 cm. inside the animal; it is covered with twelve strongly projecting sharp-edged longitudinal ridges, which begin at the twelve knobs, become higher as they run downwards (upwards in the natural position), till each of them ends in a nose-like projection. This projection is again divided by a longitudinal furrow into a larger and a smaller process. The ridges and their bifurcated ends are extremely smooth, very soft, and of a whitish colour. They consist, however, only of connective tissue, like the rest of the wall.

The varied aspect of the surface of the body is caused by the varying character of the epithelium; on the invaginated part of the wall (Pl. VI. fig. 5) it is a ciliated cylindrical epithelium, such as we find in most Actiniæ; in the other parts it is without cilia, but instead of cilia is covered with a deposit, which may be divided into two layers. One of these (Pl. VIII. fig. 1) is an irregular, fibrous cuticle, which is stained an intense red by carmine, the other is a mucous layer permeated by foreign bodies, lying outside the cuticle.

The mesoderm consists of extremely fine fibrillæ which cross one another in all directions, so that it appears as a finely granulated mass in transverse section. It is partially laid in strata parallel to the surface; in it there are small roundish concrements, which are strongly coloured by carmine, and the structure of which recalls that of granules of starch; they are made up of indistinct concentric layers, frequently appear in section like a figure 8, and are limited to the superficial layer of the mesoderm.

The existence of a strong circular muscle, which is indeed easily discovered, might be inferred merely from the high degree of contraction. It is mesodermal, and the chief bulk of it lies in the invaginated section of the wall, where it begins close to the commencement of the oral disk, or, to speak more accurately, to the origin of the tentacles (Pl. VI. fig. 5); it extends a considerable way into the outer section of the wall, into which it gradually passes. It is separated from the endoderm by a broad layer of connective substance, so that it lies nearer to the ectoderm than to its place of origin, and consists of numerous very small bundles of fibrillæ grouped together into bundles of the second order (Pl. VIII. fig. 10). The latter are usually flattened, and in transverse section show bands lying perpendicular to the surface of the endoderm.

The comportment of the oral disk is the same as that formerly described in *Calliactis parasitica.* The muscular fibres are still chiefly ectodermal, and the lamella is not thickly pleated, though at the same time single fibrillæ and groups of fibrillæ have passed into the mesoderm. The boundary line between the mesoderm and the ectoderm is therefore indistinct as in *Calliactis.*

The tentacles are small, broad at the base, and pointed towards the end; they are placed in three rows, as they probably alternate in the first and second row, whilst the third row contains double the number. Their longitudinal muscles are ectodermal and only slightly pleated.

The œsophagus and the two œsophageal grooves are of a deep brown-violet colour even in the spirit material; this is caused by fine pigment granules deposited in the ectodermal epithelium.

There are altogether four cycles of septa. Only the septa of the first order are perfect, all the others are imperfect, but, on the other hand, the latter only bear (male) reproductive organs, whilst the former are sterile.

The muscles of the septa are very strong, as Jourdan already observed in *Phellia elongata;* in the first three cycles especially the longitudinal muscles form mushroom-shaped projections in the middle of each septum, which show the delicate, dendritic figures of a repeatedly folded muscular lamella in transverse section. The transverse muscular layer is also thickly pleated, so that it is doubly remarkable that I could find no trace of a parietobasilar muscle even in sections.

All the septa seem to bear acontia; these are extremely fine, and lie coiled in the lowest section of the gastric space. I was able to make them out distinctly in transverse section, but, on the other hand, I could not find any openings in the wall.

The directive septa were fused by the free margins, nearly their entire length below the œsophagus (Pl. VIII. fig. 2). I only examined one pair of them, as I wished to destroy the single specimen taken by the Challenger as little as possible. The longitudinal muscles of one septum pass continuously into the longitudinal muscles of the other, whilst a mesenteric filament is wanting at the point of junction. The filament is confined to the short space lying between the lower margin of the œsophagus and the beginning of the fusion, where it is coiled in numerous curves. I shall leave it an open question whether it be correct to speak of a fusion of the free margins, as I have done for the sake of simplicity, or whether the union of the two septa does not rather represent a more primitive condition. I wish, however, to draw attention to one fact which seems to favour the latter view, and which I have formerly noticed repeatedly, viz., that in the young Actiniæ we frequently find the newly-formed septa of a pair connected together in the same manner as in the principal septa of *Phellia* and the secondary septa of *Tealia bunodiformis*, figured by me in Plate VIII. From this it would appear that separation takes place later on, as at a later period all the septa have free margins set with mesenteric filaments.

Bunodes, Gosse.

Sagartidæ (?) with numerous papillæ on the wall, which are placed in regular longitudinal rows, corresponding to the intraseptal spaces.

When Gosse erected his genus *Bunodes* (Trans. Linn. Soc., vol. xxi. p. 274, 1855), he included in it all Actiniæ furnished with a knobbed surface. Later, he limited this name to those Actiniæ on the walls of which the papillæ are arranged in regular, longitudinal rows (Ann. and Mag. Nat. Hist., ser. iii. vol. i. p. 417, 1858). In both instances, however, he laid it down as a rule that there should be no acontia, and the same definition of the genus was accepted by Verrill (Trans. Connect. Acad., vol. i. p. 467), by Klunzinger (Korrallthiere, i. p. 77), and by Jourdan (Annales des Scienc. Nat. Zool., ser. vi. t. x. p. 84, 1879–80). Gosse himself, however, changed his views afterwards, for, in his Actinologia Britannica, he described *Bunodes coronata* as a form in which he had once observed acontia.

Among the Challenger material I found one true representative of the Sagartidæ, the external appearance of which justified its being placed in the genus *Bunodes*. I have determined it as *Bunodes minuta*, as I consider it quite possible that the acontia have hitherto been overlooked in the species of the genus *Bunodes*. If this view be erroneous, it would be necessary to erect a new genus for *Bunodes minuta* and *Bunodes coronata*.

Bunodes minuta, n. sp. (Pl. II. fig. 12).

Wall covered with alternate rows of larger and smaller papillæ, which are confined to the upper half of the body; tentacles long and pointed, arranged in two circles, the outer circle much smaller than the inner.

Habitat.—Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth, 1600 fathoms. One specimen.

Dimensions.—Height and breadth, 1 cm.

The general appearance of the small new species of *Bunodes*, which I shall describe as *Bunodes minuta* from a single specimen found among the Challenger material, recalls that of *Paractis excavata* At first sight the body seems as broad as high (fig. 12, *a*), but if we cut open the animal (fig. 12, *b*) we see that the oral disk extends deep down into the body, so that there is but a little distance between the pedal disk and the periphery of the mouth. The diameter of the oral disk is therefore essentially greater than the breadth of the body given above.

The upper section of the wall is brownish, the lower part whitish and covered with small papillæ, which are arranged in from thirty to forty rows. Each row begins at the upper margin of the wall, and reaches half-way down the animal; the papillæ are small at first and increase in size downwards; they comport themselves differently, however, in the different rows, as rows with large papillæ and rows with small papillæ alternate irregularly. The same conditions therefore recur in *Bunodes minuta*, which exist in *Bunodes coronata*, a fact of special interest, as they are the only two species of *Bunodes* in which acontia have as yet been found (Gosse, Actinologia Britannica, p. 204).

Histologically, I find that the papillæ are formed of connective substance only, and have therefore come to an entirely different conclusion from Jourdan, who declares them

to be products of the ectoderm (Annal. des Scienc. Nat., ser. vi. t. x. p. 78, 1879–80). According to Jourdan, the papillæ which he terms "verrues glandulaires" have arisen from the epithelium pushing its way like glands into the supporting substance, and becoming wholly or nearly detached into epithelial islands. The author gives these epithelial cords as the first stage of development in longitudinal section, the detached epithelial islands in transverse section. I have obtained figures exactly similiar to those given by Jourdan, and am justified in the view that the constitution of the wall agrees in both species of *Bunodes*, but am also justified in maintaining that Jourdan's view is erroneous. These epithelial growths are linings of the depressions and furrows running on the surface, of the wall; they become deeply pleated during contraction, and may look like detached epithelial islands in transverse section, whilst in longitudinal section they may be taken for mere epithelial folds. In order to be quite certain, I made sections parallel to the surface and also examined single papillæ in transverse section; in the former we have invariably islands of connective tissue, the transverse sections of the papillæ, surrounded by an epithelial net-work but without glandular ducts; in the latter the papillæ proved to be solid growths of the connective substance. From these observations I have already, in the introduction, declared myself to be against the acceptation of the term "verrues glandulaires."

The circular muscle is entirely enclosed in the mesoderm, which, however, is only slightly thickened by it; the bulk of it extends longitudinally, is almost equal in breadth the whole way along, and is separated from the endoderm by a narrow layer of connective substance, from the ectoderm by a somewhat broader layer. The roundish bundles of fibrillæ, which merely consist of a few strong muscular fibrillæ, are divided by processes of connective substance into larger and smaller groups; this is beautifully seen in the upper part of the muscle, whilst there is a preponderance of small, irregularly distributed bundles in the lower part.

The muscles of the oral disk are divided into radial bands corresponding to the septa; they lie as a thickly folded layer in the ectoderm, like the longitudinal muscles of the tentacles. Seventy relatively long, filamentous tentacles lie on the margin of the oral disk; they run out into a fine point, and project above the surface even in the contracted animal. The outer tentacles are decidedly smaller than the inner.

In order to observe the septa properly I cut out a quadrant of the body which I made into transverse sections. From these it was plain that the directive septa running towards the œsophageal grooves alone were perfect, and did not bear reproductive organs, whilst all the other septa, not even excepting the principal septa, remain imperfect, and are amply furnished with reproductive organs (testes). The differentiation of the septa into muscular septa and reproductive septa, which is present in all Sagartidæ, extends in *Bunodes minuta* to the more limited circle of the principal septa.

If I may draw a conclusion from a small part of a single specimen, the formation of the

septa is very irregular, and seems to proceed more quickly near the directive septa. I have found that septa of the sixth and seventh orders are present in the interseptal space contiguous to the directive septa, whilst septa even of the fifth order are wanting in other parts. This assertion must of course be accepted with reserve, as the septa are so irregularly constituted that it is difficult to determine to which order a septum belongs.

I have found the acontia only in transverse section; they are oval filaments, dotted with nematocysts, quite small, and by no means numerous. This confirms my view that the acontia have hitherto been overlooked in the other species of *Bunodes*.

Family, Amphianthidæ, Hertwig.

Hexactiniæ, which are attached to the axial skeletons of Gorgonidæ with shortened sagittal and elongated transverse axis; tranverse axis lying parallel to the axial skeleton of the *Gorgonia*; circular muscle mesodermal; the principal septa only perfect and sterile.

Under the names *Actinia abyssicola* and *Actinia gelatinosa*, Moseley described two Actiniæ from the Challenger material, which agree in being attached to the stems of *Gorgoniæ* which they clasp with their base. I was only able to examine the *Actinia abyssicola*, as *Actinia gelatinosa* was not among the spirit specimens sent to me; on the other hand, I found two other new forms among the specimens, which resemble the two species determined by Moseley both in their form and mode of life.

All these forms differ so decidedly from *Actinia mesembryanthemum* that I have not only separated them generically but united them into a new family, the Amphianthidæ. Closer examination shows that the mode in which they attach themselves has influenced their organization in a very important and uniform manner. All the Amphianthidæ are elongated, corresponding to the form of the body to which they are attached, and placed in such a way that their transverse axis is greatly prolonged and runs in the same direction as the longitudinal axis of the *Gorgonia*, whilst their sagittal axis is very much shortened, and crosses the skeletal axis at right angles. The œsophagus consequently differs from that of other Actiniæ, as it is either round or even fissure-shaped in a transverse direction (Pl. III. fig. 7, *a*), and its œsophageal grooves lie so near one another that they almost touch (Pl. II. fig. 13).

The internal anatomy recalls that of the Sagartidæ. The six pairs of principal septa are sterile and alone reach the œsophagus; their interlying interseptal spaces have been modified by the elongation of the form in such a way that the four spaces belonging to the broad sides are more extensive than those belonging to the narrow sides. I was not able to make out any acontia. The circular muscle is powerful and lies in the mesoderm.

Two species already described by other naturalists, *Actinia s. catherinæ* and *Gephyra dohrnii* probably belong to the family Amphianthidæ. The former, which was described and figured by Lesson (Voyage de la Coquille, Zool., tome ii. part ii.

2, p. 74; Zoophytes, pl. ii. fig. 2), is certainly attached to a smooth underlying substance, but is, nevertheless, greatly elongated in one direction, so that, if we may judge from the drawing of it, even the corona of tentacles is divided into a right and a left half. On the other hand, *Gephyra dohrnii*, our knowledge of which we owe to G. v. Koch (Zur Phylogenie der Antipatharia. Morphol. Jahrb., Bd. iv., Suppl., p. 78, 1878), settles like a true Amphianthid on the axis of *Isis elongata*. The animals either live singly or are united by basal processes into a colony; they are fastened to the axis by a cuticular mass secreted by the pedal disk. The author has unfortunately given no details as to the position of the oral fissure with respect to the axis of the *Isis* and the constitution of the septa and œsophageal grooves.

G. v. Koch considers the *Gephyræ* as transition forms between the Actiniaria and the Antipatharia; he assumes that Actiniæ settled upon cylindrical bodies and secreted a horny mass by which they attached themselves, that later, from want of a foreign axis, they originated a proper axial skeleton by richer secretion of the adhesive mass, and moreover became branched by forming colonies. The correctness of this view is confirmed by the few remarks made by v. Koch on the structure of *Antipathes larix*. The body is elongated in the direction of the skeletal axis, and the transverse axis of the animal thereby appears lengthened, whilst the sagittal axis is shortened. This I conclude from the position of the mouth and the septa; the former is either circular or fissure-shaped; if fissure-shaped, it crosses the longitudinal axis of the animal. The different direction of the longitudinal axis of the body, and the oral fissure is very striking, but can be easily understood if we assume that the oral fissure has maintained its original extension in a sagittal direction whilst the body is prolonged in a transverse direction. We must therefore look for the directive septa on the long sides of the body. In fact, we find there two pairs of septa, which correspond to the oral angles, are sterile, and consequently comport themselves like directive septa, whilst the two remaining pairs, lying in the prolonged transverse axis, bear reproductive organs, and are therefore best termed accessory septa.

It is therefore most probable that the Amphianthidæ bring about the transformation of the Actiniaria to the Antipatharia. A more detailed study of the Antipatharia is however necessary before this view can be fully accepted; above all, it must be determined whether the paired arrangement of the septa and the presence of the directive septa can be demonstrated in the Antipatharia, and whether the sagittal and the transverse axes are directed in the same manner as in the Amphianthidæ.

Stephanactis, n. gen.

Amphiantidæ with firm wall, divided by a circular swelling into an upper and a lower section; tentacles numerous, arranged in several rows, decreasing in size from within outwards.

Stephanactis tuberculata, n. sp. (Pl. III. fig. 7).

Upper part of the wall covered with larger and smaller knobs, thickly compacted together, lower part smooth; tentacles in four to five alternating rows.

Habitat.—Station 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E. Depth, 345 fathoms. One specimen.

Dimensions.—Height, 2 cm. Length of the pedal disk, 10 cm.; length of the oral disk, 3·5 cm.; breadth of the oral disk, 2 cm.

The single specimen of *Stephanactis tuberculata*, which I was able to examine, is attached to the axis of a *Virgularia*, from which the soft cortical layer has been completely stripped as far as the Actinia extends; the pedal disk encloses the axis so completely that the two margins are pressed together, without, however, becoming fused, and so form a sheath about 10 cm. long. The wall first runs about 2 cm. close to the pedal disk, it then forms a body about 2 cm. high, which, being in a contracted condition, becomes much smaller at the upper end; the body appears fusiform when seen from the oral side (fig. 7, *a*).

A thick circular swelling, running near the upper margin, divides the wall into a smaller upper and a larger lower portion. The former is slightly inverted as in the genus *Phellia*, and may be completely overlooked from the outside. It is covered with numerous knobs, which lie thickly compacted, smaller and larger intermixed. The smaller are usually rounded spheroidally, whilst the larger stand out as nose-like projections above the level of the smaller; they may be divided into two by shallow furrows.

The lower section of the wall is essentially smooth, as the transverse and oblique wrinkles and furrows are merely caused by contraction. A more pronounced groove extends on either side in a longitudinal direction, downwards from the circular swelling at an equal distance from the two ends of the body (fig. 7). Four small knobs, in the upper surface of which I could make out a little depression with a magnifying glass, lie at the bottom of each groove. As I proved by means of transverse sections, these depressions are the openings of fine canals, which pierce the wall, and form communications between the surrounding medium and the directive intraseptal spaces which lie opposite to them; they may be fitly compared to the cinclides of the genus *Calliactis*.

The circular muscle lies in the knobbed upper part of the wall, and extends downwards as far as the circular swelling. It occupies nearly the entire thickness of the mesoderm, which however it does not greatly increase; in transverse section it is elongated, nearly of equal breadth throughout, and is only reduced a little in size towards the lower end. The bundles of fibrillæ are very small, and distributed with tolerable regularity in the fundamental substance, so that we can hardly observe any arrangement into larger or smaller groups.

Though the sphincter is tolerably strongly contracted, we can make a partial survey of the oral disk. It bears more than a hundred tentacles, placed in from four to five

indistinctly defined rows. The tentacles of the innermost row are short, but broad at the base, powerful and compressed; towards the outside the tentacles become smaller and more slender. Indistinct radial furrows, caused by the distribution of the muscles, run from the corona of tentacles to the oral opening. The muscles consist of tough, ectodermal fibrillæ, the lamella made up of which lies thickly folded both in the oral disk and in the tentacles.

The oral opening is elongated to an oval in the same direction as the whole body of the animal, and from analogy to other Actiniæ we might expect to find the œsophageal grooves at the ends of the oval. In this case, however, they lie exactly in the middle of the two broad sides and in the contracted animal so near that they almost touch. If we cut out the part in question (fig. 7, *b*) we see that the œsophageal grooves are very broad and reach far down, whilst the remaining irregularly pleated part of the œsophagus only hangs down a little way into the stomach.

Except the two pairs of directive septa, which are attached to the œsophageal grooves, the other four pairs of principal septa only are perfect, whilst all the secondary septa terminate on the oral disk. The former are sterile, whilst the latter bear the reproductive organs, which were testes in the specimen examined. There are large marginal stomata in the septa, and in addition to these perioral stomata in the perfect principal septa.

I endeavoured to discover the mode of arrangement of the septa by cutting out two sextants contiguous to the directive septa and making them into transverse sections. I found extremely irregular conditions, and in spite of all my trouble I am unable to explain them with any certainty. Five pairs of septa of considerable strength lie in each interseptal space, but as they were equal to one another I was not able to determine their various ages from the difference in size. I am therefore undecided between two opinions; either the pairs of septa of the second order are doubled and three pairs of septa of the third order are present, or else there is only one pair of septa of the second order developed and the pairs of septa of the third order have undergone duplication.

In the interseptal spaces of the third order I found either only a single pair of the fourth order or two pairs of the fourth order; so that duplication seems also to have partially taken place here.

It would be interesting to examine the sextants occupying the narrow side of the body in order to see whether the arrangement of the septa is more regular in them. I refrained from this, however, in order not to injure the single specimen of the species. We may, however, certainly assume that the irregular development of the septa is the consequence of the elongation of the body, and this is shown by the partial duplication of their number. There would be nothing remarkable in such duplication, since the interseptal spaces belonging to the broad sides are abnormally extended.

Stephanactis abyssicola (Pl. II. fig. 13).

Actinia abyssicola, Moseley, Trans. Linn. Soc., ser. ii., Zool., vol. i. p. 297, pl. xlv. fig. 5.

Both parts of the wall smooth; circular swelling distinctly defined; tentacles in two alternating circles.

Habitat.—Station 46. May 6, 1873. Lat. 40° 17′ N., long. 66° 48′ W. Depth, 1350 fathoms. Two specimens.

Dimensions.—Length, 3·5 cm.; height, 0·5 cm.

Colour.—(Determined by Moseley in the fresh condition), the part inside the circular swelling a beautiful rose-red with a few darker radial streaks; the remainder of the wall reddish-yellow and paler, especially the circular swelling; oral disk rose-red with paler tentacles.

Of the two specimens of *Stephanactis abyssicola*, one was so much destroyed as to be of no use for anatomical examination, and I did not wish to cut up the other as it was the only well-preserved specimen of the species. *Stephanactis abyssicola* is clearly so closely allied to *Stephanactis tuberculata* that I deem a more detailed anatomical study unnecessary, and therefore confine myself to the description of its external appearance.

The body is elongated like that of *Stephanactis tuberculata*, but not prolonged into a process at either end. The pedal disk enclosed the stem of a *Mopsea* so completely that its margins were firmly joined on the lower side. The line of union is slightly undulated, and the insertions of from ninety to one hundred septa, which lie more closely compacted at the two ends of the body, shine through beside it. The spaces between the septa are larger towards the broad sides, but become narrower again towards the middle of the broad sides.

The circular swelling, which Moseley erroneously terms the muscular swelling, is, however, distinctly defined on either side. A small depression, in which rises a papilla, lies on either side close under the circular swelling in the middle of the broad side, resembling those which we have met with in the same position, but in larger number, in *Stephanactis tuberculata*. Otherwise, the wall is smooth, both in the portion lying inside the circular furrow and that lying outside. It is incompletely contracted, so that the oral disk, the oral opening, and part of the points of the tentacles are visible. As the œsophageal grooves plainly occupy the middle between the two ends of the oval oral fissure, it may be again safely assumed that the elongation of the body has taken place in the direction of the transverse axis. Numerous small tentacles (sixty according to Moseley) lie in a double row on the margin of the oral disk.

Stephanactis abyssicola is distinguished from *Stephanactis tuberculata* by its smaller size, by the absence of knobs on the upper part of the wall, and by the lesser number of cinclidal papillæ. These are all differences, however, which may possibly arise from difference of age, and it is quite likely that the two species might require to be united, if

we were able to examine a larger number of specimens. In this case, the species would keep the older name of *Stephanactis abyssicola.*

Amphianthus, n. gen.

Amphianthidæ with a firm wall, which is covered with fine papillæ but not divided into two sections by a circular swelling.

Amphianthus bathybium (Pl. III. fig 11).

Upper section of the wall furnished with twenty-four longitudinal furrows, which disappear as they run downwards, and covered with very small papillæ, mostly grouped in transverse rows.

Habitat.—Station 241. June 23, 1875. Lat. 35° 41′ N., long. 157° 42′ E. Depth, 2300 fathoms. One specimen.

Dimensions.—Length, 4 cm.; height, nearly 1 cm.

I have placed here beside the *Stephanactis* a small Actinia of which a single specimen was dredged from a great depth. It agrees with the genus *Stephanactis* in having an elongated form, and in being attached to a cylindrical foreign body. I was unfortunately unable to determine whether or not the internal anatomy also agrees, as the septa were so badly preserved that, in examining the piece, in which, from analogy to the forms in question, I expected to find the directive septa, I was unable to arrive at any definite results, even by transverse sections. In what follows I shall, therefore, merely give a short description of the form and of the surface of the body.

The Actinia was firmly attached by its base round the stem of a *Gorgonia* unknown to me, so that the margins of the pedal disk clasped one another by alternating indentations like the notched margins of many bivalve shells (fig. 11, *b*). The insertions of from ninety to one hundred septa appearing through the disk may be followed as white lines proceeding a little way from the margins. At first sight the upper part of the wall seems smooth, but under a tolerably strong magnifying glass we see that it is covered with numerous very fine knobs, which look like the papules of an exanthema, and are arranged in transverse rows (fig. 11, *a*), which lie at tolerably regular distances from one another, and are separated by shallow furrows. The latter are crossed by twenty-four longitudinal furrows, which are most distinct at the upper margin of the wall, but become shallower before they reach its middle portion.

The wall is so strongly contracted at the upper end, that the oral disk is completely covered; in correspondence with which we find in longitudinal sections a circular muscle of considerable size, having the same form as the circular muscle of *Stephanactis.* I only observed these differences, viz., that the bundles of muscles are stronger, more numerous, and more thickly compacted.

Family, ILYANTHIDÆ, Gosse, *pro parte.*

Hexactiniæ, having the aboral end of the body rounded; without pedal disk.

As I include in the family of the Ilyanthidæ only those forms which have the septal arrangement of the Hexactiniæ, I define it in a much more limited sense than Gosse (Actinologia Britannica, p. 227) or even Verrill (Memoirs Boston Soc., vol. i. p. 26). Verrill has detached the Cerianthidæ only, but left the Edwardsiæ in the family, while Allmann (Quart. Jour. Micr. Sci., new ser., vol. xii. p. 394), my brother and myself (Actinien, p. 124), and Angelo Andres (Mittheilungen der Zool. Stat. zu Neapel, Bd. ii. p. 123) have most clearly pointed out that the latter also ought to be separated. I am of the opinion that even excluding the Edwardsiæ does not free the family from foreign elements, for it is not at all likely that *Halcampa albida* and *Halcampa producta* with twenty tentacles, *Halcampa microps* with sixteen tentacles, &c., conform to the hexamerous type of arrangement of the tentacles.

By the absence of the pedal disk the Ilyanthidæ form a transition to the tribe Edwardsiæ, on account of which I have placed them at the end of the Hexactiniæ; in their internal anatomy they are also allied to the Edwardsiæ. *Halcampa clavus*, especially, which I am now about to describe, is so clearly an intermediate form that I was for long dubious whether I should treat of it under the Edwardsiæ or the Hexactiniæ.

Halcampa, Gosse.

Ilyanthidæ with elongated, vermiform body; without sharply defined circular muscle; the posterior end may be distended into a vesicle; œsophageal grooves indistinct or wanting.

In all systematic descriptions of the Ilyanthidæ published by former authors, the genera *Edwardsia* and *Halcampa* are placed very close together; according to Gosse, they are only distinguished from one another by the facts, that the middle part of the body in *Edwardsia* is surrounded by a sheath, an "epidermis," which is wanting in *Halcampa*, and that the body is divided into three sections, the "capitulum," the "scapus," and the "physa." Angelo Andres (*l. c.*, p. 137) has recently made use of a much more important anatomical character, viz., the presence of only eight septa ("octoseptazione") in *Edwardsia*, while there are always at least twelve septa in *Halcampa*. I only attach importance to the different arrangement of the septa, and therefore will place forms with tripartite wall in the genus *Halcampa*, provided only that they be true Hexactiniæ.

Halcampa clavus (Pl. III. figs. 1, 4, 10; Pl. XII. figs. 8, 9, 11; Pl. XIII. figs. 2, 4–7).

Actinia clavus, Quoy et Gaymard, Voyage de l' Astrolabe, Zoologie, iv. p. 150, pl. x. figs. 6–11, 1833.
Iluanthus clavus, Milne-Edwards, Histoire des Corall., tom. i. p. 284.

Wall smooth, with twelve longitudinal furrows, and numerous small openings at the posterior end of the body; twelve tentacles, each with an adaxial and an abaxial longitudinal furrow; six pairs of septa.

Habitat.—Station 149. Off Kerguelen Islands. (*a*) January 9, 1874. Lat. 49° 16′ S., long. 70° 12′ E. Betsy Cove. Depth, 25 fathoms. Two specimens. (*b*) January 29, 1874. Christmas Harbour. Depth, 120 fathoms. One specimen.

Dimensions.—Height, 1·5–2 cm.; breadth, 0·5–1 cm.

The three specimens of *Halcampa clavus* which were sent me for examination varied in size; the two specimens taken in Betsy Cove were smaller than the one dredged up in Christmas Harbour, and differed from it in habit of body. I believe, however, that they should be referred to the same species, as the slight difference in size and form may be the consequence of difference in age and degree of contraction, and their anatomical constitution harmonizes completely. I examined the larger specimen, which was specially well preserved, and one of the smaller ones.

The body is divided by two circular constrictions into three sections lying one behind the other. The middle section, the scapus—if we adopt the nomenclature proposed by Gosse for *Edwardsia*—in the largest individual was rather longer than the other two sections taken together, and about 1 cm. broad (Pl. III. figs. 1 and 4); it passed anteriorly into a short neck-like part bearing the tentacles, the capitulum, and posteriorly into a terminal part, 0·5 cm. long and broad, the physa. A cuticular deposit, like that covering the scapus of the *Edwardsiæ*, did not exist, but on the other hand the wall is regularly divided by twelve longitudinal furrows, which begin at the upper end between the twelve tentacles and reach as far as the lower umbilically depressed end. The longitudinal furrows are crossed by numerous transverse furrows, which, however, may be caused by the strong contraction of the animal.

The wall is transparent and thin-membraned except at the points where the scapus passes into the capitulum and the physa; at the points mentioned it is greatly thickened by increase of the supporting substance on the one hand and by numerous pleatings of its endodermal and ectodermal surfaces on the other. The pleatings are caused by an increase in the lamellæ of the circular muscles, and may therefore be termed the upper and lower sphincters, though they are by no means sharply defined. If we examine the wall closely in longitudinal section we see that all over the inner side there is a layer of circular fibres. The underlying supporting substance is divided into two layers, an inner, narrower, nearly homogeneous layer, which stains a darker red in carmine, and an outer, broad, fibrous layer, the two being separated by a sharp line. The inner layer is pleated at tolerably regular intervals, into supporting folds, which run circularly, and project into the gastric space; they usually remain simple, and are rarely bifurcated at their margins. Their surface is covered with numerous very fine, secondary folds, which bear a layer of muscular fibrillæ, so that each circular fold appears finely pinnated

when seen in sections taken longitudinally through the wall. The two sphincters are in fact merely local accumulations of these muscular rings, which are exceedingly strongly developed (Pl. XIII. fig. 2). The muscular rings rise much more than usual above the surface of the wall, and seldom remain simple, but divide in transverse section into two or three processes; they may even divide repeatedly, and in this way give rise in transverse section to the candelabra-like figure shown in Plate XIII. fig. 2. As the upper sphincter lies at a little distance from the margin of the oral disk, it causes a deep constriction of the wall and a corresponding external collar-like fold (Pl. III. fig. 1, *a*).

The twelve tentacles are placed on the margin of the oral disk where the latter turns over into the wall; they are pointed in the smaller specimens, obtuse and compressed in the larger. They are distinguished in both cases by two longitudinal furrows, one of which runs on the adaxial side (fig. 1, *b*), the other on the abaxial (fig. 1, *a*). The muscular system is ectodermal, and tolerably thickly pleated; it has the same character on the oral disk, which is so small that the tentacles appear to be placed immediately on the oral margin.

The oral opening (Pl. III. fig. 1, *b*) is circular and enclosed by twelve swellings. It leads into a long similarly shaped œsophagus, which hangs down in the middle of the body; the lumen of the œsophagus is narrow above and becomes wider below. I was not able to find out œsophageal grooves, either in surface view after opening the animal (Pl. III. fig. 1), or in transverse section (Pl. XIII. fig. 4); but, on the other hand, it is set with twelve strongly-marked longitudinal ridges, corresponding to the insertions of the septa. As the free margins of the longitudinal swellings are thickened, the intermediate furrows are closed so as almost to form canals.

The septa are thin, veil-like lamellæ, with a thick longitudinal muscle which lies much nearer the œsophagus than the wall. The muscle begins in the lower part, the physa, bulges out in the region of the scapus, becomes narrow again in the upper part of the body, and ends on the oral disk not far from the oral opening (Pl. III. fig. 1). In transverse section it forms a muscular mass of considerable size, which rests like a cushion on the surface of the septum, but is marked off from it by a deep groove which runs beneath its margin on either side (Pl. XIII. fig. 4). As to its structure it is a thickly pleated portion of the longitudinal muscular layer, which, moreover, forms a small longitudinal cord close to the wall. The rudiments of a parietobasilar muscle are also found in a similar position on the side of the weakly developed transverse muscles.

The septa are placed at regular distances from one another, though at the same time they are associated together in pairs. Two opposite pairs of septa have longitudinal muscles on the sides turned from one another, whilst on either side there are two pairs with the longitudinal muscles turned towards one another. This is, therefore, an arrangement of the septa which must be taken as a starting point for all Hexactiniæ. *Halcampa clavus* has only the principal septa, which, as we have already shown, are distinguished by a

peculiar mode of development, whilst the accessory septa, which are paired from the beginning, are still wanting.

The constitution of the septa in *Halcampa clavus* shows further peculiarities worthy of notice, which seem to me to indicate its relation to the Edwardsiæ. As I was preparing a series of sections through the one half of the physa of the larger specimen, it struck me that three septa (including the pair of directive septa) were not so strong as the other septa, inasmuch as their longitudinal muscular cords became sooner indistinct (Pl. XIII. fig. 7). In the second smaller *Halcampa*, in which I was able to make sections through the entire body, four septa were somewhat smaller than the eight others; and, finally, Strethill Wright has described a parasitic *Halcampa* living on Medusæ (*Halcampa fultoni*), in which we can distinguish four stronger and eight weaker septa (Ann. and Mag. Nat. Hist., ser. iii. vol. viii. p. 133, 1861). All this shows that an unequal development of the septa, and, consequently, a difference in their morphological value, is not unusual in *Halcampa*. If we assume that the eight stronger septa are homologous with the septa of *Edwardsia*, whilst the four other septa are new formations, then the genus *Halcampa* would present us with transition forms between the Edwardsiæ and the Hexactiniæ.

I shall not discuss the point in question further, but I wish to draw particular attention to the importance of a detailed investigation of the Ilyanthidæ for a phylogenetic study of the Actiniaria. I am of opinion that an investigation of the position of septa, extended not only over the mature animals, but also over the larvæ, would furnish us with very interesting explanations as to the manner in which the paired arrangement of the septa has been developed among the Actiniaria. Of course a mere enumeration of the septa would not suffice, but it would be necessary to lay down definite characters for the determination of the septa newly formed in the Ilyanthidæ, with special reference to the distribution of the muscles and the relations of position depending upon it.

Reproductive organs were present in all the septa; ovaries in the larger of the two specimens examined, testes in the smaller; they lay below the œsophagus, inwards from the longitudinal muscles. The ovaries were admirably preserved, so that I availed myself of the opportunity to make a more detailed examination of the origin of the ovicells and the structure of the filamental apparatus. The youngest ova are again portions of the epithelium (Pl. XII. fig. 11), and become surrounded very gradually by the supporting lamella; if the latter be strongly coloured, we see from ova of considerable size, such as that given in fig. 11, that they are not yet entirely surrounded by the supporting lamella, but that the interior of the follicle of the ovum still communicates with the epithelium by means of a wide, roundish opening. A fine hatching is visible on that portion of the ovum which closes the opening as though fine filaments were present on the surface; these are either processes of the ovum itself, which serve to connect it with the epithelium, or they are the bases of the epithelial cells. This point

cannot be definitely determined after preservation in spirit, but would require material preserved in osmic acid.

After the ovum has passed into the supporting lamella, it still reaches the bases of the epithelial cells by means of a narrow process, the cells having undergone the modifications already described (fig. 8). The cells are fine filaments, with few granules, and compressed into a body shaped like a gustatory bulb; they are much more numerous than in *Corallimorphus*.

The part of the filamental apparatus formed of epithelial cells lies originally in the same plane as the opaque, granular, epithelial cells, but later, when the ova increase in size, it occupies the bottom of a depression in the epithelium, surrounded by the neighbouring cells which have increased in length. On the other hand, it never passes over into the mesoderm, so that the filamental apparatus remains in a condition which leaves room for further differentiation in *Corallimorphus*. On the larger ovicells there is a narrow cortical layer which is distinguished from the central parts by a structure only indistinctly preserved in spirit. Radial lines indicate, however, that the protoplasm has become divided into small rod-shaped pieces.

Whilst acontia are wanting, the configuration of the mesenteric filaments is the same as in other Actiniæ. I was able to make out a marginal stoma by the help of transverse sections in the upper part of the septa, but I could not determine whether a perioral stoma exists or not.

After the septa are free from their reproductive organs, their mesenteric filaments, and their stronger, specialized muscular cords, they still extend as far as the centre point of the rounded posterior end of the body. Two of the septa are connected in such a way as to form a partition wall separating the four septa on the one side from the six septa on the other (Pl. III. fig. 10). This arrangement precludes the existence of a central posterior pore, but in place of it I found numerous eccentric openings, which are, however, so small that they could not be perceived on the surface, even under a strong magnifying glass. I observed them by making sections transversely through the posterior body-wall of the larger animal, and parallel to the convex terminal surface of the smaller.

The openings are placed in a circular zone at a little distance from the centre point. In sections parallel to the surface I found two of them in the same radius, one outside the other, and I therefore presume that there are about twenty-four of them; each radial chamber probably containing two (Pl. XIII. fig. 5). This point cannot, however, be easily determined from preserved material, as in such a case the wall is pleated, and also from its convex curvature is not well adapted for making such sections.

If we prepare a series of transverse sections, we have a successive view of a large number of openings, often two in the same transverse section, placed symmetrically left and right from the middle; from the relation of their positions to the septa, which can also be seen in transverse section, we may assume that they are regularly distributed

over the different radial chambers (fig. 6). There is always a distinct hole in the supporting lamella through which the ectodermal epithelium of the pedal disk sends a cellular mass projecting like a mushroom towards the gastric space above the surface of the endodermal epithelium. This epithelial mass completely closes the opening, but consists of two layers of cells, firmly pressed together; when these part asunder, which must be the case when the posterior body-end of the animal becomes distended, an open canal is formed in the epithelium, through which water can penetrate into the inside of the body. Similar arrangements probably exist in *Edwardsia;* the aboral section of this Actinia, being likewise separated from the preceding by a constriction, can be alternately distended and contracted, and during this process the openings might be of great service.

Tribe II. PARACTINIÆ.

Actiniaria with septa united in pairs. Septa of each pair furnished with transverse muscular fibres on the sides turned from one another, and with longitudinal muscular fibres on the sides turned towards one another, excepting the two pairs of directive septa, which are opposite one another, and have longitudinal muscles on the sides turned from one another, and transverse muscles on the sides turned towards one another. Number of the septa not determined by the number six. Mouth fissure-shaped, œsophagus with two œsophageal grooves and two œsophageal lappets.

I have separated two forms from the Hexactiniæ because the number of their antimeres does not increase in multiples of six, and I have given them the name of "Paractiniæ" because they resemble the Hexactiniæ in the most important points, and therefore represent a parallel group. Above all, they are furnished with œsophageal grooves and have septa arranged in pairs, of which two pairs corresponding to the œsophageal grooves are placed opposite one another, have longitudinal muscles on the sides turned from one another, and are therefore true directive septa. The tentacles have undergone retrograde metamorphosis in both forms, which differ, however, so greatly from one another that I consider them as the representatives of two different families.

Family, SICYONIDÆ.

Sessile Paractiniæ with tetramerous arrangement of the septa; circular muscle mesodermal; tentacles transformed by retrograde metamorphosis into small knob-like stumps.

The most striking characteristic of the Sicyonidæ—apart from the retrograde metamorphosis of the tentacles, which is also met with among the Hexactiniæ—is the tetramerous arrangement of the septa. Hæckel, as we know, sought in his Generelle Morphologie for soft-membraned ancestors of the fossil Tetracorallia, and believed he had found one of their descendants in *Cerianthus.* Recent works on the anatomy of *Cerianthus*

have greatly lessened the probability of Hæckel's view being correct, as in the mature animal the number of the septa is always even, but otherwise very variable. In *Sicyonis crassa*, on the other hand, we have before us an animal in which the number four is as persistent as the number six in the Hexactiniæ, and which, moreover, has the same paired arrangement of the septa as we meet with in the existing hexamerous corals. It is therefore quite possible that the Sicyonidæ and Tetracorallia may be closely related.

Sicyonis, n. gen.

Sicyonidæ, with discoid, flattened body, smooth wall, and alternating reproductive septa and muscular septa.

Sicyonis crassa, n. sp. (Pl. IV. figs. 1-9).

Sixty-four wart-like tentacles placed in two alternating rows; circular muscle weak; oral disk covered with numerous fine radial furrows.

Habitat.—Station 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Depth, 1600 fathoms. One specimen.

Dimensions.—Height, 2 cm. Diameter of the pedal disk, 7 cm.; of the oral disk, 9 cm.

The new species, which I have named *Sicyonis crassa*, is one of the most interesting Actiniæ dredged from great depths, both on account of the constitution of the tentacles and of the arrangement of the septa. The body of the single specimen before me is cake-shaped, as the transverse measurement of the pedal disk amounts to 7 cm., and that of the oral disk to 9 cm., whilst the height only amounts to 2 cm. The height would, however, certainly be greater in a natural state, as the animal had been very much compressed in the packing.

The body is tolerably tough, more, however, from the thickness of its walls than from the firmness of its tissue. The consistency of the latter is between that of cartilage and of gelatinous tissue, and consists in all parts of the body of a homogeneous fundamental substance enclosing numerous extremely small cells. The fundamental substance is also traversed by numerous bundles of fibrillæ, which become very distinct in preparations stained with carmine. These bundles have a wavy course, and become connected from time to time so as to form a reticulate framework. It was not possible to recognise the natural colour of the animal.

The pedal disk (fig. 2) is marked by radial furrows; a large number, more than 100, begin at the margin, of which some reach the centre, whilst others do not extend so far. Their course is irregularly waved and indented, and they correspond to the insertions of the septa inside the animal.

The wall is small in height, and divided by a deep circular constriction into an upper and a lower half (fig. 9); it appears, on the whole, smooth and only furrowed irregularly on the surface in consequence of the contraction of the animal. The circular layer of fibres on the inside is very weak, both because the separate fibrillæ are very fine, and because the layer, formed by them, is only slightly pleated. The circular muscle at the margin of the peristome is also insignificant; it lies immediately outside the tentacles, and produces about four or five narrow circular swellings on the inside of the wall (fig. 1). It belongs completely to the mesoderm, in which it is embedded as a very narrow streak, close under the endoderm. The fibrillæ, like those of the wall, are very fine, and united in small bundles which lie close to one another, and are only separated by a small amount of intervening substance. In transverse section, and under weak magnifying power, the muscular layer therefore presents the appearance of a finely granulated mass.

The most important parts for the definition of the species are the oral disk and its tentacles. The surface of the oral disk is marked by sixty-four radial furrows, which run from the swollen margin of the mouth towards the bases of the tentacles, and are caused by the attachments of the septa. They are, moreover, correlated with the arrangement of the radial muscles, the layer of which always either becomes thinner or is completely interrupted along a line below every furrow. The muscles are further mesodermal, and so deeply embedded in the supporting lamella that they lie at equal distances from the endodermal and the ectodermal surfaces. The separate fibrillæ (fig. 6) are very powerful, and the way in which they are grouped gives rise in transverse section to a figure recalling the conditions known in the vertebrata. A few fibrillæ are closely compacted into a primitive bundle, several such bundles unite to form a secondary bundle (fig. 8), and these again are united into larger groups. Each portion of the muscular layer lying between two radial furrows contains several groups of such bundles.

There are sixty-four tentacles in all, distributed in two alternating circles. They present a very unusual appearance, and are short knob-like elevations with a broad oval base, and are pierced by a wide opening at the point. This gives them the appearance of sucking cups, and on this account I have named the animal *Sicyonis*. The surface is repeatedly pleated, and the interior also shows distinct circular folds (fig. 9). The walls are very thick as far as a thin margin surrounding the terminal opening (fig. 3). The radial muscular fibres of the oral disk make their way as longitudinal cords into the tentacles, and have the same arrangement in the middle of the broad layer of connective tissue as we have already discussed in the description of the oral disk. Examined in transverse section (fig. 5), they are deposited in a ring, which, however, is interrupted on the side turned towards the margin of the peristome. There the layer of connective tissue is very thick, but only contains a few isolated bundles of muscular fibrillæ. We see, moreover, in longitudinal section (fig. 3), that the cords of muscular fibres do not make

their way into the thin margin surrounding the opening in the tentacle, but terminate abruptly before they reach this point. The margin, therefore, merely consists of a lamella of connective substance, covered by two layers of epithelium passing into one another at the free edge.

On the œsophagus (fig. 4), the two œsophageal grooves at once strike the eye as deeply incised furrows, bounded by broad folds and running zig-zag, as secondary transverse folds project alternately left and right. The other longitudinal furrows, which run, ten in number, on either side between the œsophageal grooves, are less distinct. From the oral disk the œsophagus is separated by a thick lip-like swelling, divided into twenty-four parts corresponding to the number of the longitudinal furrows of the œsophagus.

The number of the pairs of septa amounts in all to sixty-four. Sixteen of these are of equal size and are inserted into the œsophagus; alternating with these we find sixteen other pairs only a little smaller, which end on the oral disk, but like the others are purely muscular septa. On the other hand the last thirty-two pairs of septa, which are equally distributed in the interspaces between the muscular septa, bear only the reproductive organs and are furnished merely with a very thin muscular layer. There is a very pronounced difference in size between the smallest muscular septa and the reproductive septa, such as I have already described in *Ophiodiscus*. In *Sicyonis* also the septa are merely thin-walled mesenteries for the reproductive organs, thick masses of which (testes) occupy the free margin of the fold; they only extend upwards to one-third the height of the animal, and are entirely wanting in the angle between the wall and the oral disk (fig. 9).

Fig. 9 shows the distribution of the muscles on the muscular septa. On the side of the longitudinal muscles a single cord radiates like a fan towards the œsophagus and the central parts of the oral disk; on the side of the transverse muscles the parietobasilar muscle extends half way up the wall, where it occasions the constriction already mentioned. In the perfect septa a small opening lies in the neighbourhood of the mouth. The muscular septa and genital septa are finally to be distinguished by the fact that the former only bear mesenteric filaments.

Sicyonis crassa has another character in common with *Ophiodiscus* besides the differentiation of the septa into reproductive and muscular, viz., the relation in which the number of the pairs of septa stands to the number of the tentacles.

In the majority of Actiniæ there are at least twice as many tentacles as there are pairs of septa, so that each intraseptal and each interseptal space has its own special tentacle. In *Sicyonis* and *Ophiodiscus* there is an equal number of pairs of septa and of tentacles; the thirty-two intraseptal spaces of the muscular septa only have their own special tentacles, whilst the other tentacles belong in common to the thirty-two intraseptal spaces of the reproductive septa and the sixty-four adjacent interseptal spaces. This also shows the rudimentary character of the reproductive septa, since they

are of so little importance in the constitution of the body of the Actinia that their appearance has not even been followed by an increase in the number of the tentacles.

Family, Polyopidæ, Hertwig.

Paractiniæ, without pedal disk, posterior end of the body round and saccular, with aboral opening (?); tentacles transformed into stomidia by retrograde metamorphosis.

In earlier systems the Polyopidæ would have been placed among the Ilyanthidæ, to which family, apart from the absence of tentacles, they bear a strong external resemblance. It is quite possible that at some future time forms may be found which shall furnish a closer link between our Polyopidæ and the Edwardsiæ formerly described as Ilyanthidæ; more especially as the Edwardsiæ occupy in some measure a central position in the midst of the Actiniæ, and send out lines of affinity in various directions. At present, however, it is more convenient to separate the Edwardsiæ and the Polyopidæ as the paired grouping of the septa, which is so pronounced in the latter, is still wanting in the former.

Polyopis, n. gen.

Polyopidæ with smooth wall, the surface having longitudinal furrows indicating the position of the septa; circular muscle wanting.

Polyopis striata (Pl. II. fig. 11; Pl. XI. figs. 1–12).

Wall with thirty-six longitudinal lines; oral disk with thirty-six strongly developed radial swellings and thirty-six marginal stomidia arranged in a circle.

Habitat.—Station 299. December 14, 1875. Lat. 33° 31′ S., long. 74° 43′ W. Depth, 2160 fathoms. One specimen.

Dimensions.—Height, nearly 2 cm.; breadth, 2 cm.

Colour.—(Determined from the spirit specimen) wall saffron-yellow, oral disk whitish, œsophagus dark brown.

The small Actinia without tentacles, which I call *Polyopis striata* (ὀπή = opening), was probably sac-shaped during life; its rounded posterior end probably stuck in the sand, whilst its broad anterior end formed by the oral disk projected freely. In consequence of packing, the animal was pressed quite flat, the oral disk and œsophagus turned out and very much injured, the septa consequently misplaced and torn. The difficulty of examining the septa was increased by the fact that from the hardening by alcohol, the septa had stuck together, and could not be easily separated by dissection. The preservation of the tissue was satisfactory, especially that of the epithelium on the oral disk, œsophagus, and septa.

The wall is of a delicate yellowish colour, which is contained in the endoderm, as the ectoderm is rubbed off and the mesoderm colourless and transparent after the epithelium

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is removed from the inside. The colour is caused by numerous small granules, which completely fill the endodermal epithelial cells.

The lower end of the sac-shaped body, the aboral pole of the longitudinal axis, is denoted by a small depression, which is equally visible on either side, and is caused, it seems to me, by a microscopically small opening found at this spot (Pl. XI. fig. 11). In order to settle this question by transverse sections, I cut out the portion of the wall containing the opening, and laid it to stain in carmine, but unfortunately it got lost.

On the exterior in the periphery of the aboral depression there are six shallow, radial furrows, which soon become less distinct as they run upwards. Instead of them, thirty-six longitudinal streaks begin, the external signs of the origins of the septa, which run at an equal distance from one another to the margin of the oral disk. The inside of the wall is covered with a smooth layer of circular muscular fibres, which are never compacted into a distinct sphincter, which explains why the upper end of the wall is not contracted at all.

The structure of the oral disk, which projected like a proboscis in the animal examined, requires a more detailed description. Thirty-six stomidia lie close to its peripheral margin; these are fine, longitudinal fissures enclosed by thickened lips, their greatest diameter extending in a radial direction. Through the stomidia we see the inside of the body, looking alternately into an intraseptal and an interseptal space; they therefore alternate with the septa which are inserted into the narrow portions of the oral disk, lying between two stomidia. Sections perpendicular to the surface of the disk and parallel to its margin through the region of the stomidia are, therefore, divided into as many pieces as there are septa, and each piece consists of a septum and the section of the oral disk belonging to it (Pl. XI. fig. 9).

Distinctly marked radial thickenings (Pl. II. fig. 11; Pl. XI. fig. 6), extending to close upon the oral opening, proceed inwards from the stomidia. They are broad and shallow in the middle of the oral disk, but rise towards the outside and towards the inside into narrow comb-like ridges, the outer ridges being divided into two small folds. These folds end near the stomidia and twist repeatedly during their course so as to produce S-shaped figures. Each two contiguous folds enclose a fissure along which we can pass a needle a little way into the interior of the corresponding radial thickening, which shows that the inner part of the thickening is hollowed out by a radial invagination.

From the varying relations of the different parts of the oral disk the transverse sections also present very different figures, according as they are made nearer to or further from the oral margin. Fig. 7 gives a section corresponding to the line δ in fig. 6. The supporting lamella is thickened in the middle between each two septa and covered by a repeatedly folded muscular layer. Inwards from this point, in the region of the line ϵ, above each radial chamber, the supporting lamella rises like a ridge which also bears a thickly pleated muscular lamella, as shown in fig. 5. The section given in fig. 3, whose position

is determined by the line γ, shows the same figure, but with this difference, that in this case hollow spaces appear in the supporting lamella, which either lie as triangular gaps at the bases of the ridges, or force themselves as fissures into the ridges themselves. These hollow spaces, found in transverse section, correspond to the pouch-shaped invaginations, which extend into the peripheral part of each radial swelling; here and there I found accumulations of cells in the spaces,—the remains of the epithelium lining them, which unfortunately was badly preserved. In fig. 1 we have a transverse section taken through the small folds at the beginning of the radial thickenings, along the line α. The figures 1–3 show an irregular arrangement of the muscles, as they are sometimes divided perpendicularly, sometimes obliquely, sometimes parallel to their direction. This irregularity may be explained partly by the tortuous course taken by the beginning of the radial swelling, partly by the fact that the muscular fibres, which originally extended horizontally, have been slightly diverted from their straight direction by the comb-like elevations of the supporting lamella.

The œsophagus was too much injured to allow of its constitution being determined by means of dissection. I was able, however, to examine pieces of it, recognisable by their brown-violet colour, in a series of sections, and to make out openings which lie under the oral margin and lead into the radial chambers. It seemed to me that there was an opening surrounded by a swollen margin between every two insertions of the septa (fig. 4). The openings are not all of the same size, as many of them can be recognised in a whole series of transverse sections as long fissures, whilst others are only visible in three to four moderately thin successive sections. They can hardly be considered artificial productions, in the first place, because the surfaces of the epithelium of the two sides pass evenly into one another at the margin of the opening, and secondly, on account of the comportment of the muscular system. The œsophagus of *Polyopis striata* has exceptionally ectodermal longitudinal muscular fibres, which are only apparent in thin transverse sections, as they are extremely fine. The muscular layer is thickly pleated at the rounded margins of the openings, so that it may here be regarded as a sphincter capable of closing the opening.

The septa correspond to the longitudinal ridges on the surface of the wall, and are therefore thirty-six in number; they lie at perfectly equal distances from one another, but are in pairs notwithstanding, as may be seen from the arrangement of the muscles. Among them there are two pairs of directive septa (fig. 8) which are separated from one another by eight pairs of ordinary septa. The latter vary very much in size, although I was not able to observe any arrangement in cycles of unequal value; I consider it most probable that we have here a tetramerous arrangement of the septa, but that a pair of septa too many has been formed in one interspace on either side. Downwards the septa reach nearly as far as the aboral opening; they are, however, of different sizes, so as to present the figure given in fig. 11, β.

The longitudinal muscles are slightly pleated, the transverse muscles not at all. There is a special muscular cord on the same side as the transverse muscle, which extends close to the wall, becomes broader as it runs downwards, and is homologous in position with the parietobasilar muscle of other Actiniæ. Further, it appears to me that all the septa reach the œsophagus, are all furnished with reproductive organs (in the present instance with testes), and have all a small perioral and a very large marginal opening (fig. 12). Unfortunately I could not decide this point with any certainty, as only a few septa, such as that given in fig. 12, could be dissected out; most of them were sticking together so that the mode in which the reproductive organs were distributed on the septa was never clearly seen in transverse sections.

Tribe III. Monauleæ.

Actiniaria with paired septa, but with only one pair of directive septa.

The Monauleæ form the third and last group in which the paired arrangement of the septa is distinctly pronounced, and therefore come nearer to the Hexactiniæ and Paractiniæ than the Zoantheæ and Ceriantheæ. It is remarkable that there is only one pair of directive septa, a fact which may perhaps be explained by the obliteration of the second pair.

From the absence of the second pair of directive septa, it follows that the body is exactly bilaterally symmetrical, as it is divided into symmetrical halves by only one divisional plane which runs through the intraseptal space of the directive septa. This divisional plane passes through an interseptal space on the opposite side, and divides the remaining pairs of septa equally, half lying on its right and half on its left. The whole number of the pairs of septa is consequently unequal.

There is only one œsophageal groove, caused by the marked shortness of the directive septa, and on account of this I have chosen the name Monauleæ (αὐλός, a groove or tube). This groove was not very distinct, however, in transverse sections in the species examined; it would probably come out more clearly if looked at from the surface.

As I only know one species, it would be little to the purpose to give special diagnoses for the family and genus. I shall therefore proceed at once to discuss the species.

Family, Monaulidæ, Hertwig.

Scytophorus, n. gen.[1]

Scytophorus striatus, n. sp. (Pl. III. fig. 6; Pl. XIII. figs. 1, 3, 8).

Sessile Monaulidæ with seven pairs of septa and fourteen longitudinal furrows on the

[1] σκῦτος=leather.

wall; the wall covered with a tough cuticle; no circular muscle; tentacles fourteen in number, of medium size, arranged in a single circle.

Habitat.—Station 150. February 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Depth, 150 fathoms. Two specimens.

Dimensions.—Height, 2·7 cm.; breadth, 0·8 cm.

Colour.—(Determined from the spirit material) brownish-yellow.

The Actiniæ without pedal disk and with rounded, aboral end mostly vary in the arrangement of their septa from the type predominating in the whole section, as was explained in the Introduction, but this is rarely the case with the sessile forms. *Scytophorus striatus*, which represents a new species, furnishes one of the few examples of this variation which have come under my observation. I found two specimens of it in the Challenger material, so that I was able to examine one of them thoroughly.

The body is very much elongated, and even in a state of contraction measures 2·7 cm. in length, whilst it is only 0·8 cm. in breadth (Pl. III. fig. 6). The upper part of the body is also inverted considerably (more than 0·5 cm.), as we see from the longitudinal sections, a formation recalling *Phellia pectinata*, which has, however, an entirely different structure. The surface is deeply incised by fourteen longitudinal furrows, which are the more distinct because the surface is not soft as in the majority of Actiniæ, but of a leather-like consistency. This is owing to the presence of a strong cuticle, whose structure and relation to the underlying epithelium are best understood by transverse sections (Pl. XIII. fig. 1).

The cuticle consists of two layers; (1), a superficial layer, which hardly stains at all in carmine, but keeps its natural tint, to which is due the yellowish colour of the entire animal; and (2), a deeper layer which becomes an intense red when treated with this reagent. The two layers are tolerably well defined, at some points even by a smooth line. The stratification parallel to the surface, usually found in cuticular secretions, can be recognised in the lower deposit, and striation perpendicular to the surface is also present at many points.

As the cuticle is of nearly equal thickness throughout, the longitudinal furrows of the body, which show in transverse sections as deep indentations, are caused entirely by the underlying epithelium and the supporting lamella. Both of these have an equal share in causing the difference of level. The supporting lamella, a homogeneous fundamental substance with scattered fusiform and branched cells, is very thick between each two furrows, and becomes thin below the indentations, and in the same way the epithelium is unusually high between the furrows, but reduced to an almost imperceptible layer below them. Where the epithelial cells are elongated they are separated from one another by interspaces; they are easily torn in preparing transverse sections, so that an artificial hollow space arises between the cuticle and the supporting lamella.

The whole integument undergoes modification at numerous small, sharply defined

spots. The supporting lamella projects like a papilla, and so reaches within a little distance of the cuticle, and the epithelial cells are shortened correspondingly, but thickly compacted; their bases sink a little way into the supporting lamella, so that the contour of the latter is notched, whilst at the same time they converge from their broader basis towards a small spot of the cuticle which has a different appearance. The outer cuticular layer pierces the inner layer, and extends to the top of the epithelial cells; it thus forms a conical projection, the central part of which is stained deep red by carmine, whilst the periphery only preserves the yellower colour, so on the whole it shows in transverse section the figure given in Plate XIII. fig. 1.

The cone of the outer cuticular layer is sometimes forced apart from the epithelium by a thin stratum of the inner layer (fig. 8), but in this case the projection of the supporting lamella is also wanting, and the epithelium has the same nature as usual.

I consider myself justified in explaining the conditions of structure of the cuticle described above by the supposition that the cuticle undergoes a periodical change, a kind of desquamation. The outer, yellow layer is the hardened cuticle; this probably becomes detached after a time, and is replaced by the inner cuticle, which stains so easily in carmine. The circumscribed spots at which the yellow cuticle reaches the epithelium, indicate the points at which it is more firmly attached to the surface of the body; they are the fastening nodes of the cuticle. The connection is gradually dissolved when the yellow layer is forced apart by a fresh layer, even from the points of attachment to the epithelium, in the manner just described.

The number of the fastening nodes in each transverse section is very large; I counted more than twenty in one section, including those in process of retrograde formation, all on the whole of equal size. I also examined these peculiar formations in longitudinal sections, and found the same figures as in transverse sections. I lay stress on this fact as it proves that we are not dealing with long streaks.

The cuticle passes on to the inverted part of the wall, which in the contracted animal projects downwards more than 0·5 cm. into the inside of the body; it becomes thinner, especially the superficial yellow layer.

A sharply defined circular muscle, such as I have described in most true Actiniæ, is wanting in *Scytophorus striatus;* instead of it, there is a peculiar differentiation of the endodermal layer of muscular fibres. The layer of fibrillæ is raised at short intervals into folds, which are strengthened by the supporting substance, and produce branched figures in transverse section. These bushes of muscles, which are covered by epithelium only, project freely into the gastric space: they are most strongly developed in the upper contracted and inverted section of the wall, where they are thickly branched and placed closely together so as to replace the absent sphincter.

The ectodermal muscular fibres of the small oral disk and its, to all appearance, equally small tentacles are very weak. The tentacles partly hang down into the œsophagus, are

also partly invaginated and retracted into the radial chambers in a way which is more common among the Octocorallia than among the Hexacorallia ; in this case the sequence of the layers is inverted in transverse sections, as the ectoderm is turned inwards, the endoderm outwards. There are fourteen tentacles in all, each of them belonging to a radial chamber.

On the œsophagus there are alternately eight longitudinal furrows and eight longitudinal thickenings (Pl. XIII. fig. 3), but little can be said about their constitution, as it was plainly very much influenced by the contraction of the body. The deepest furrow belongs to the interspace between the two directive septa, and may be regarded as an œsophageal groove, even though I was not able to make out distinctly that it is covered by a specially constituted epithelium. The transverse section of the œsophagus is roundish, so that the flattening in the direction of the transverse axis, common to many Actiniæ, is wanting.

The septa are perfect without exception. They are thin lamellæ bearing a very strong muscular pennon, in the middle between the œsophagus and the wall. At this point the longitudinal muscles are pleated in a sharply defined space nearly as thickly as in *Tealia bunodiformis;* besides these, a special cord of longitudinal muscles runs along the wall and a rudimentary parietobasilar muscle lies in a similar position on the side of the transverse muscles. A wide marginal stoma can be seen in transverse section between the two longitudinal muscular cords.

The arrangement of the septa and the nature of the reproductive organs is of the highest importance. *Scytophorus striatus* is the only Actinia known at present, in which the number of the pairs of septa is unequal. This is not an accidental abnormality, as it is caused by the absence of the second pair of directive septa and not by irregular growth of the different parts of the body; this was clear from both the specimens under examination, as in each one wall was furnished with fourteen longitudinal furrows, corresponding exactly to the fourteen septa, *i.e.*, to the seven pairs. The existing pair of directive septa is only distinguished from the other septa by the lamellæ being shorter, on which account the wall and the œsophagus approach nearest to one another at this point.

Scytophorus striatus belongs to the small number of Actiniæ in which hermaphroditism has been undeniably observed; all the septa (the directive septa included) bear ova in their upper sections, many of which were almost mature in the specimen I examined, whilst the lower sections bear testes, though these were not so numerous as the ovicells.

Tribe IV. EDWARDSIÆ.

Actiniaria with eight septa; among which are two pairs of directive septa, whilst the remaining four septa are not paired; all the septa furnished with reproductive organs; tentacles simple, usually more numerous than the septa.

Though Quatrefages, the discoverer of the Edwardsiæ (Mémoire sur les Edwardsies, nouveau genre de la famille des Actinies, Annales d. Sc. Nat. Zool., ser. ii. vol. xviii. p. 65, 1842), observed correctly that these Actiniæ have only eight septa, this important character has not been sufficiently taken into account by most of the more recent writers. Milne-Edwards and Gosse, who attach too much importance to the external characteristics of the animal, had the absence of the pedal disk principally in view, and united the Edwardsiæ with similar forms, *Ilyanthus*, *Cerianthus*, &c., into the group of "Actinies pivotantes," or the family of the Ilyanthidæ. Allman was the first to draw attention in a short notice (Quart. Jour. Microsc. Sci., new ser., vol. xii. p. 394, 1872) to the detached position of the Edwardsiæ, as he maintained them to be forms which, in the distribution of the septa, more closely resemble the Alcyonaria and the extinct Tetracorallia. My brother and I have shown more recently, from a thorough anatomical examination of the position of the septa (Actinien, pp. 124 and 137), that the Edwardsiæ occupy an intermediate position between the larvæ of the Actiniæ with eight septa and the Alcyonaria. In the Alcyonaria the septa are arranged in such a way, that reckoned from one end of the sagittal axis, all the eight septa (four left and four right) bear longitudinal muscles on the faces turned away from the starting point, whilst in the larvæ Actiniæ the first four only (two left and two right) have longitudinal muscles on the faces turned away, and the four following on the faces turned towards the starting point, so that we find the same relative arrangement, whichever end of the sagittal axis we start from. In the Edwardsiæ we meet with the number six and two, *i.e.*, considered from one fixed end of the sagittal axis the first six septa are constituted like those of the Alcyonaria, the last two like those of the Actiniæ. As in the Actiniæ the two pairs of septa placed one at each end of the oral fissure form the directive septa, two pairs of the directive septa are therefore likewise present in the Edwardsiæ.

The correctness of the view, briefly recapitulated above, has been further corroborated by a newly published work of Angelo Andres (Intorno all' Edwardsia Claparedii; Mittheil. der zoolog. Station zu Neapel, Bd. ii. p. 123); at the same time he pronounces in favour of Allman's view that the Edwardsiæ may bear the same relation to the Tetracorallia as the Actiniæ do to the skeleton-forming Hexacorallia. I do not agree with him on this point. Apart from the number of the calcareous septa, the formation of the skeleton is the same in the Hexacorallia and Tetracorallia, and it is therefore probable that similar relations have existed among the soft parts of the body, and that the paired arrangement of the septa was already developed in the Tetracorallia. As this is not the case in the Edwardsiæ, I am inclined to seek for points of connection with the Rugosa in such forms as *Sicyonis crassa*.

There was no true *Edwardsia* among the Challenger material; but I was long duboius as to whether it might not be expedient to include among them those forms in which the paired arrangement and the number twelve of the septa begin to be developed,

as for example *Halcampa clavus*. We may gather from this how closely the Edwardsiæ are connected by transition forms with the other Actiniæ, and how advisable it is to discuss them along with the latter, and to separate them from the Alcyonaria. From this point of view the constitution of the tentacles is of great importance, as they in no way resemble the tentacles of the Alcyonaria.

Tribe V. ZOANTHEÆ.

Actiniaria with numerous septa of two different kinds, smaller, imperfect, sterile microsepta, and larger perfect macrosepta furnished with reproductive organs and mesenteric filaments; the two kinds usually placed alternately, so that each pair is composed of a larger and a smaller septum; two pairs of directive septa at the ends of the sagittal axis, one pair containing only macrosepta, the other only microsepta; only one œsophageal groove, corresponding to the larger directive septa; animals usually forming colonies; wall usually traversed by ectodermal canals, and having the outside encrusted with foreign bodies.

Zoologists differ very much in their opinions as to the limits and the definition of the Zoantheæ. Milne-Edwards (Hist. des. Corall., tom. i. p. 298) includes in this division only colonial, sessile forms which increase by basal gemmation and have a leather-like sheath hardened by encrustation with sand granules (faux polypiéroïde); Gosse agrees with him (Actinologia Britannica, p. 295), but considers the encrustation with sand granules as a secondary character. Most zoologists keep to the definition given by Milne-Edwards and Gosse.

In 1856, Steenstrup described an Actinia under the name *Sphenopus marsupialis*, which closely resembles the Zoantheæ, but is distinguished from them by not forming colonies and not being sessile. (Overs. Kongelige danske Videnskab. Selskabs Forhand., p. 37, 1856). As Gray (Proc. Zool. Soc., p. 235, 1867) included this Actinia among the Zoantheæ, he set aside the characters used by Milne-Edwards, viz., the formation of colonies and the sessile mode of life, but without replacing them in the diagnosis by new characters, which would be at once common to all Zoantheæ, and distinctive from other Actiniaria. To what degree the sharp limitation of the Zoantheæ suffered from this may be seen from the fact that Gray included in this tribe the genera *Edwardsia*, *Halcampa*, &c.

The discovery of *Sphenopus* led to difficulties as to the limitation of the Zoantheæ which were also not obviated by the fact that Verrill considered *Sphenopus* to be related to the Edwardsiæ, to which it has certainly a strong external resemblance. But anatomically *Sphenopus* agrees so thoroughly with the Zoantheæ that it cannot be separated from them. A study of the arrangement of the septa is the only possible means of discovering distinctive characters for the division.

Angelo Andres (Quart. Jour. Micros. Sci., new ser., vol. xvii. p. 221, 1877) and my brother and myself (Actinien, p. 127) had already pointed out that the position of the septa in the Zoantheæ was regulated on an entirely different principle from that in other Actiniaria, though G. v. Koch was the first to find out the true nature of it. He discovered what I fully corroborate, that the septa present are of two different sizes (Morphol. Jahrb., Bd. vi. p. 359, 1880). The larger or macrosepta only reach the œsophagus and bear reproductive organs and mesenteric filaments, whilst the smaller or microsepta are sterile and end on the oral disk; the latter are not, as I formerly supposed, young septa destined to be developed into larger, but are really rudimentary formations.

Both the larger and the smaller septa bear muscles on both sides: one side bears longitudinal fibres, the layer of which is, however, only slightly pleated, the other side bears fibres which rise obliquely, and are homologous with the transverse muscular fibres of the other Actiniæ, though they can easily be mistaken for longitudinal fibres in transverse sections. There is here, therefore, a predisposition to the paired arrangement of the septa, the existence of which was first recognised by G. v. Koch. Each pair consists of a small and a large septum, having longitudinal muscles on the faces turned towards one another (Pl. XIV. fig. 2). The two pairs of directive septa form an exception, however, as one pair of them, the ventral, contains large septa only,—the other pair, the dorsal, only small septa; in some Zoantheæ, we must also except two pairs of ordinary septa which lie right and left at a little distance from the small directive septa, and contain macrosepta only (Pl. XIV. fig. 3).

The manner in which the larger and smaller septa are distributed can be more accurately determined if we start from the directive septa, and disregard provisionally the grouping in pairs. In the Zoantheæ, as in all Actiniæ, two kinds of septa alternate; in the septa of the one system the muscles are disposed in the same way as they are in the ventral pair of directive septa, whilst in the other system the case is reversed, and they have the same disposition as they have in the dorsal pair of directive septa. The septa which have the same arrangement of the muscles as the small dorsal directive septa, viz., the dorsal septa, are likewise small, whilst the others, the ventral septa, are strong; it is only in the neighbourhood of the small directive septa that the conditions are reversed as the dorsal septa are strong, and the ventral septa are weak. We can therefore divide the ordinary pairs of septa into two different regions; in the one (the larger, or ventral region), the ventral septa of the single pairs are macrosepta, and the dorsal septa are microsepta, whilst in the other (the dorsal region), the reverse is the case, and the dorsal septa are macrosepta. When all the pairs of septa are equally developed, the two regions are bounded on either side by microsepta, but those two microsepta are often wanting left and right, and in this way the pairs formed of macrosepta alone, which have been already mentioned, are produced: these contain two large dorsal septa of the dorsal region and two large ventral septa of the ventral region.

The correlation, which exists in all Actiniaria between the œsophageal grooves and the directive septa, is also shown in the Zoantheæ, for there is only one œsophageal groove, whilst the other is wanting, in correspondence with the rudimentary nature of the directive septa to which it should belong. The tentacles, on the other hand, are equally developed and placed in two circles, the inner of which belongs to the intra-septal spaces, the outer to the interseptal spaces.

All the characters taken into account by former naturalists in the diagnosis of the Zoantheæ are of subordinate value when compared with the peculiar conditions just mentioned. The animals are united into colonies either by means of branched stolons or by means of a broad basal plate, but there are also solitary forms which are embedded with their rounded aboral ends in the sand like the Edwardsiæ. The entire surface of the wall is often permeated with foreign bodies, though in many specimens such encrustations are wanting completely. Finally, the canals, which make their way from the ectoderm into the wall, where they become branched and connected into plexuses, are confined to certain forms only.

In the division of the Zoantheæ I agree chiefly with Verrill, who divided the species forming colonies into four genera; *Mammilifera*, *Zoanthus*, *Palythoa*, and *Epizoanthus*. The former two are distinguished from the latter by the absence of sand encrustations. *Zoanthus* and *Epizoanthus* are distinguished from *Mammilifera* and *Palythoa* by the fact that in the former two the polyps project plainly above the common basis, whilst in the latter two they are united up to the free end by the basal cœnenchyma. I have restricted the family Zoanthidæ to those genera which form colonies, and have associated all those which are solitary under the name Sphenopidæ.

Family ZOANTHIDÆ.

Zoantheæ forming colonies; the individuals of a colony connected with one another by endodermal canals, which run out from the gastric space at the lower end of each polyp.

Zoanthus, Cuvier, *pro parte*.

Zoanthus, Verrill.

Zoanthidæ without sand encrustations and with a slightly developed cœnenchyma consisting either of a plexus of stolons or of a thin plate; the single polyps projec to a considerable height above the cœnenchyma.

Zoanthus, sp. (?) (Pl. XIV. figs. 1–4 and 6).

Habitat.—Bermuda Islands.

Dimensions.—(Of the individual polyps): height, 0·1–1·3 cm.; breadth, 0·1–0·4 cm.

Numerous species of the genus *Zoanthus* have been described which resemble one another closely, and probably only differ slightly in their anatomy, so that the species can only be determined by the colour, the number and arrangement of the tentacles, &c. This is the reason why I have not given any specific name to the single specimen of the genus *Zoanthus* found among the Challenger material, in which the colour of the body and the nature of the tentacles could not be made out, and why I have refrained from giving any diagnosis of species, as from insufficient knowledge of the closely allied species it is impossible to determine which characteristics belong to the whole genus and which to the individual species.

The colony, which was about 4 cm. long and 2 cm. broad, was firmly attached to a stone, and consisted of some thirty individuals varying greatly in size. The smallest of these are little knobs which hardly project 1 to 2 mm. above the cœnenchyma, the largest are long cylindrical tubes, more than 1 cm. in length. They lie so thickly compacted that the cœnenchyma is almost entirely covered, and only shows here and there as a thin plate. The cœnenchyma is abundantly developed on the margin into stolons, which are alternately broad and narrow.

I made a thorough anatomical examination of three individual polyps of different sizes, which were highly contracted like all the animals of the colony. The upper end of the wall is not only contracted but inverted a little; the only indication of the point at which we can reach the interior of the body is a small navel-like depression. Apart from the folds caused by contraction, the surface of the body is perfectly smooth.

The wall (Pl. XIV. fig. 4) is of considerable thickness, and consists histologically of a homogeneous fundamental substance, with fine fibres embedded in it. The fibres are hardly double contoured, are slightly waved, and run sometimes directly, sometimes obliquely, from one epithelial surface to the other. They begin at the endoderm with a granular enlargement which seems to pass directly into the epithelium; towards the ectoderm they branch repeatedly behind one another. They are furnished with nuclei, and therefore bear a strong resemblance to the muscular fibres of the Ctenophora, but their state of preservation did not admit of determining the histological value of the fibres.

The cells of the connective substance are strongly granulated bodies, either rounded or branched.

Finally, we find canals in the wall, such as do not exist in any other Actiniaria, though they are found in the Alcyonaria. These canals vary greatly in diameter; the smaller are simple cords of cells, and only the larger ones show a lumen surrounded by a layer of epithelium. As the canals repeatedly ramify and anastomose, they form a thick net-work, which extends from the endoderm to the ectoderm, but is thickest near the latter. Kölliker's observations show that in the Alcyonaria the canals are produced from the ectoderm, which is also the case in *Zoanthus;* I have repeatedly found

that the epithelium of the body-surface sinks like a funnel into the mesoderm, where it is prolonged into a broad or narrow canal which soon begins to throw out branches (fig. 2).

The ectodermal epithelium is covered by a fibrous cuticle, which recalls the "epidermis" of *Phellia pectinata* and *Cereus spinosus*. The endodermal epithelium has produced a thin, circular muscular layer, and is traversed by small, roundish, sharply-contoured bodies. I consider these bodies as parasitic, unicellular organisms of the same kind as those which my brother and I have already observed in various species of Actiniæ. There was no visible trace of the usual yellowish and greenish colour, but this was probably owing to the preservation in spirit.

In the inverted part of the wall I found a sphincter of a very peculiar nature (Pl. XIV. fig. 1). It consists of two perfectly separate portions, a larger, which begins at the outer part of the wall, bends round at the inverted edge, and extends a little way into the invaginated part, and a smaller, which lies at the boundary between the wall and the oral disk. When the animal is expanded, this second portion of the sphincter will lie above the larger portion of the muscle; when the animal is contracted it occupies the lowest part of the invaginated wall. A space without muscles, which does not contract, and, therefore, becomes pleated, lies between the two portions.

Both parts of the sphincter are mesodermal and placed at an equal distance from the endoderm and the ectoderm; their bundles of fibrillæ are arranged irregularly and repeatedly crossed and interwoven in their course, so that the same transverse section passes obliquely through some, transversely through others. The bulk of them lies in the inverted part of the wall, whilst the muscles merely form a thin layer in the outer part of the wall.

The oral disk bears a double corona of small tentacles, corresponding in number to the septa, in that part of its periphery which is contiguous to the wall. The inner tentacles communicate with the intraseptal spaces, the outer tentacles with the interseptal spaces, the two are therefore placed alternately. The muscular system of the oral disk and of the tentacles is ectodermal and extended in a smooth layer.

The distribution of the muscles can be very well recognised in the septa of the strongly contracted polyps. The longitudinal muscular lamella is pleated both in the small rudimentary septa and in the large septa so as to form a small muscular pennon, whilst the fibrillæ which rise obliquely are less strongly developed (Pl. XIV. fig. 2). The paired grouping of the septa is consequently very distinct, and we can also easily distinguish the two pairs of directive septa from the ordinary pairs. The number of the latter varies according to the size of the animal. In the largest polyp examined, there were in all twenty-nine pairs of septa (Pl. XIV. fig. 3). Of the two pairs of opposite directive septa, one pair is rudimentary, does not bear mesenteric filaments, and does not reach the œsophagus, whilst the other pair is perfect, bears mesenteric filaments,

and does reach the œsophagus. The remaining twenty-seven pairs are distributed in the space to the right and left of the œsophagus, so that thirteen pairs lie on the one side and fourteen pairs on the other. Each pair consists of a larger perfect macroseptum, and a smaller imperfect microseptum.

If we term the side marked by the larger pair of directive septa, the ventral side, we see that almost all the pairs of septa are placed in such a way that the larger, perfect septa are directed ventrad, the smaller imperfect septa dorsad; the two pairs of septa next to the small dorsal pair of directive septa form the only exception to this rule as their dorsal septa are the larger, their ventral septa the smaller. We can therefore distinguish two systems of pairs of septa, a dorsal and a ventral. The result is the following perfectly regular arrangement of the septa: as a rule the larger and smaller septa alternate, but at three points two small septa lie between two large septa, viz., at the dorsal end where the small pair of directive septa lie, and a little way further right and left from the directive septa, where the dorsal and the ventral systems of septa are mutually bounded by small septa.

At the ventral end, on the other hand, we find three spaces between large septa, in which the small septa are wanting, viz., the intraseptal space of the large directive septa, and the two adjacent interseptal spaces. To explain this more clearly I give formulæ for the dorsal (1), and for the ventral side (2), showing the distribution of the septa.

1. Dorsal side, &c. *gk gk* ⋮ *kg kg* $\underline{k \mid k}$ *gk gk* ⋮ *kg kg* &c.
2. Ventral side, &c. *kg kg* *kg kg* $\underline{g \mid g}$ *gk gk* *gk gk* &c.

In these formulæ the letter *g* indicates the large septa, *k* the small septa, the dotted lines the boundaries between the dorsal and ventral systems, the black lines the position of the sagittal axis, the underlining the directive septa.

Three of the twenty-seven pairs of septa are still imperfectly developed, and much smaller than the others; the two pairs lying to the right and left of the ventral directive septa, and the extra pair of septa which is only present on the one side. As I discovered from other polyps of the same *Zoanthus* colony, the two pairs named at first are the youngest in age. Their macrosepta resemble on the whole the small septa of the other pairs; they have no mesenteric filaments, and the uppermost section only reaches to the œsophagus.

I got an explanation of the manner and sequence in which the septa are developed from examination of a small polyp, only a few millimetres high. It had forty-eight septa in all; exclusive of the directive septa, there were twenty-one on one side and twenty-three on the other (Pl. XIV. fig. 6). In the region of the smaller directive septa, the conditions were the same as in the developed polyps, but towards the ventral side the

septa all became smaller as they approached the larger directive septa; on one side only the first seven, on the other side only the first six, macrosepta reached the œsophagus, then followed five other macrosepta which still decreased in size, so that the smallest, which came next the ventral directive septa, hardly projected at all into the gastric space. The microsepta left off still earlier, for they became smaller in exact proportion to the macrosepta, and as they were in general less they disappeared sooner. On the ventral side the directive septa only were perfect, and were separated by a wide interspace from the septa which were next in development.

Two facts may be deduced from the above observations: (1) The macrosepta and microsepta can be distinguished from the first by the difference in size; they develop independently and at different periods, whilst in the Hexactiniæ and Paractiniæ the septa of a pair start simultaneously and are of the same size from the first. (2) The septa are not produced regularly in the periphery of the body of the Actinia, but within a limited, ventral productive zone. The dorsal septa are therefore the oldest, the ventral septa the youngest, with the exception of the directive septa, which are developed very early.

The third polyp was intermediate between the two specimens described, both in the size and the number of its septa, which amounted to fifty-two. A more minute description of it is therefore unnecessary, and I shall conclude my remarks on the Zoantheæ with some details as to the structure of the septa.

A cellular cord, or a canal filled with cells, runs in the supporting lamella of the septa in immediate proximity to the wall (Pl. XIV. fig. 2). It is usually divided into several cords by commissures of the supporting lamella and is of such strength that the whole septum becomes visibly and locally thickened. I never could make out any connection between this septal canal and the ectodermal cords of the wall in any of the numerous sections which I prepared, and I am inclined to believe that it is produced from the endoderm. My reason is that I have observed that the same roundish bodies which are to be found in the endoderm, which I regard as parasitic, unicellular organisms, force their way into the septal canal, but never into the canals of the wall. I attach less importance to the origin of the canals, as they seem to be connected with the endoderm here and there where the septa spring from the wall. However, the figures, which led me to consider such a mode of connection as probable, did not furnish sufficient proof of its actual existence.

The structure of the mesenteric filaments is essentially the same as in the Actiniæ; during the greater part of their course they consist entirely of the median glandular streak, and it is only a little way below the œsophagus that they are widened by the addition of paired ciliated streaks, the surface of which is indented at regular intervals by transverse furrows. This upper section of the mesenteric filaments appears to me identical with the "flattened organs" described by Verrill as "having a curved or crescent form and a transversely striated surface,—attached to the principal radiating lamellæ, near the base of the stomach" (Trans. Connect. Acad., vol. i. p. 494). Verrill, Andres, and others

erroneously consider these organs as peculiar to the Zoantheæ, and explain them to be gills, a view which is, however, quite unwarranted.

I did not find reproductive organs either in the three polyps minutely examined or in several others which I only opened longitudinally.

The cœnenchyma consists of the same tissue as the wall of the polyps, but the proportions of the component parts are altered. The branched fibres are more scanty and crossed irregularly in every direction, whilst the cells of connective substance are remarkably abundant, and many of them have assimilated black granules, and so become branched pigment cells. The ectodermal canals are more numerous than usual, and form a thick net-work; it is often difficult to distinguish them from the endodermal connective tubes, which run from one polyp to another, and which also may become branched into small vessels.

Epizoanthus, Gray.

Zoanthidæ, in which the outer layer of the body is encrusted with sand granules; cœnenchyma a thin lamella usually stretched over Gasteropod shells which have been abandoned by their owners and are inhabited by *Paguri*; polyps projecting considerably above the surface of the cœnenchyma.

Epizoanthus parasiticus (Pl. III. figs. 2, 9, 12; Pl. XIV. fig. 5).

Zoanthus parasiticus, Verrill, Memoirs Boston Soc., vol. i. p. 34.

The upper part of the wall of the polyps, which is a few millimetres broad, separated from the lower by a circular furrow, forming a shallow disk when contracted, and covered with forty radial ridges; tentacles seventy to eighty, filament-shaped, arranged in two rows. Colony parasitic upon a Gasteropod shell, the calcareous components of which have been absorbed and replaced by the cœnenchyma.

Habitat.—Station 235. June 4, 1875. Lat. 34° 7′ N., long. 138° 0′ E. Depth, 565 fathoms. Two specimens.

Dimensions.—Height of the individual polyps, 1·5–2·5 cm.; breadth, 1·4–1·7 cm.

Epizoanthus parasiticus, of which there were two specimens among the Challenger material, belongs to those Actiniaria which settle as parasites on shells inhabited by hermit crabs. As Verrill, who was the first to give a detailed account of *Epizoanthus*, observed, the Gasteropod shell is almost entirely dissolved, even the columella being completely replaced by the cœnenchyma of the parasite. The form of the shell, however, is still retained, and the hermit crab continues to live comfortably inside, undisturbed by the changes which his home has undergone. The snail shell can only be recognised externally by the wide opening and the point which projects as a stumpy knob.

The number of the individual polyps and their arrangement on the surface of the body is almost the same in both the colonies investigated. Eight polyps are uniformly distributed along that circumference which divides the upper half of the shell from the lower when the *Pagurus* is crawling about on the bottom; the polyps just mentioned are the largest and most powerful of the colony, and are plainly most favourably placed for acquiring nutriment, as they are always at a little distance from the bottom (Pl. III. fig. 2). A medium-sized polyp rises nearly in the middle of the convex upper side of the colony, and in one colony a second smaller polyp lay close beside it. On the lower side an obviously rudimentary polyp grows on the posterior margin of the opening of the shell (fig. 9); it has the best position on the lower side, which is on the whole disadvantageous to development, as it is raised from the bottom as long as the *Pagurus* is crawling about, and only lies upon it when the *Pagurus* has retreated into the shell. In the colony consisting of eleven individuals there was the indication of a twelfth between the eight marginal polyps. It may be taken as a general rule that the distribution of the polyps on the surface of the colony is not accidental, but that those spots are preferred in which the animal has room for free development, and also a convenient position for acquiring nutriment.

The whole surface of the colony is covered by a dirty yellow substance permeated by sand granules, which can be easily scraped off; underneath this the fundamental substance of the wall becomes visible, which resembles cartilage in consistency and colour, and is also hardened superficially by sand granules. This hardened layer is so thin that it can be removed by sections parallel to the surface, and yet leave sufficient fundamental substance both in the cœnenchyma and the wall for transverse sections. These conditions were extremely favourable to examination, so that I regretted the more that the colonies were not better preserved.

The large marginal polyps were 2–2·5 cm. high, 1·4–1·7 cm. broad, and slightly flattened from above downwards. The upper part of the wall is inverted, and forms a horizontal roof; this might be taken at first sight for the oral disk, as it is separated from the bulk of the wall by a circular furrow, and also differs in its structure, being furnished with numerous (about forty) radial ridges, already observed by Verrill, which are broad where they begin at the margin and become narrower as they run inwards. The radially striated part of the wall is distinguished from the oral disk by being encrusted with sand granules like the rest of the wall. In the middle of this horizontal roof is a fissure running parallel to the margin of the colony, through which, in many polyps, the points of the incompletely retracted tentacles peep out. Through this fissure we may reach the inside of the polyp, first passing through the space lying above the oral disk.

The fundamental substance of the wall is homogeneous, but in transverse and longitudinal sections it shows a striation parallel to the surface of the body, which looks as if it were deposited in layers (Pl. XIV. fig. 5). The striated layers are crossed by fine

fibres, which end in repeated branches under the ectoderm like those of *Zoanthus*, but are more numerous, more sharply contoured and waved repeatedly in their course. Besides the branched corpuscles of connective tissue, small and large islands of cells lie in the supporting substance; I presume that these islands of cells represent the system of cellular cords which are always found in *Zoanthus*, but are wanting in *Epizoanthus*. At certain points they are prolonged into longish sausage-shaped cords, several of which may also become united into a dendritic figure. In many parts of the cœnenchyma I still found the remains of a branched vascular system, which formed very small meshes, especially about the endodermal connective tubes. I therefore feel justified in my conjecture that the oval islands of cells are caused by the unsatisfactory state of preservation, and are produced by the disintegration of a system of anastomosing cords.

A powerful circular muscle lies in the horizontally inverted part of the wall; it is broad at the beginning of the oral disk and becomes narrower from within outwards. The imperfect state of preservation did not allow me to give any histological description of its bundles of fibrillæ which run in the mesoderm between the ectoderm and endoderm. I could not make out that it was divided into a larger and a smaller part as in *Zoanthus*.

The large size of the individual polyps of *Epizoanthus parasiticus* renders them admirably suited for dissection by means of knife and scissors. If we cut open the animal longitudinally and spread it out by turning back the upper end of the wall (Pl. III. fig. 12), we find adjacent to the latter, the double corona of long, filamentous tentacles, the aggregate number of which amounts to seventy or eighty. The tentacles of the inner row alternate with those of the outer. The oral disk extends far down, and is covered with shallow radial furrows corresponding to the tentacles. It is divided by a distinct thickening from the œsophagus, in which our attention is at once attracted to the single œsophageal groove. When spread out the œsophageal groove forms a scutiform plate, separated from the adjacent parts of the œsophagus by longitudinal furrows, and divided by a more distinct median furrow into a right and a left half; it is prolonged far below the lower margin of the œsophagus, so that it is almost twice its length. The triangular lappet formed in this way is likewise divided into two by the prolonged longitudinal furrow, and deeply indented at the end.

Below the lower margin of the œsophagus there are seen thirty-two to thirty-four septa, the zigzag margins of which are caused by the reproductive organs; these are macrosepta, the microsepta only becoming visible when the others are folded back. I examined the mutual relations of the two kinds of septa in transverse sections and with essentially the same result as G. v. Koch in *Epizoanthus axinellæ* (Morphol. Jahrb., Bd. vi. p. 359, 1880). Two pairs of directive septa lie at the ends of the sagittal axis, the dorsal pair consisting of microsepta, the ventral of macrosepta; the latter only reach the œsophagus and are

attached close to the œsophageal groove, which is also ventral. Besides these there are fifteen pairs of septa on either side (if the aggregate number of pairs of septa is increased to thirty-three, there are sixteen on one side and fifteen on the other), which consist of (1), a pair of septa adjoining the dorsal directive pair, and having the dorsal septum larger than the ventral; (2), thirteen pairs of septa situated towards the ventral aspect of the body, and having the ventral septum larger than the dorsal; and (3), a pair consisting of two macrosepta and lying between the two above mentioned groups. The distinction then between *Epizoanthus parasiticus* and *Epizoanthus axinellæ* on the one hand and the true *Zoanthus* on the other, is that in the latter the two systems are separated by microsepta, in the former by macrosepta, so that a pair of septa is madeup of one septum from either system.

The remarks made by me on the septal canals and mesenteric filaments of *Zoanthus* apply equally to *Epizoanthus parasiticus*. The reproductive organs were well developed, and seemed to lie only on the macrosepta, and that without exception; they were testes in the specimen which I examined in transverse section.

The individual animals of the *Epizoanthus* colony were united at the base by a tolerably thick crust, in which numerous canals run from one polyp to another; all the canals extend with repeated anastomosis in one and the same layer of the cœnenchyma. Hence if we cut a colony through longitudinally, the cœnenchyma is separated by the vascular stratum into a broader external and a narrower internal layer; the character of the tissue is the same in both, except that the inner layer is without branched fibres. The gastric spaces of all the polyps reach as far as the vascular stratum, in which lies a very large canal surrounding the opening of the shell like a ring (Pl. III. fig. 9).

The hollow of the shell enclosed by the cœnenchyma is lined by a chitinous membrane, which lies firmly attached to the thin layer of the cœnenchyma, and has a structure of its own. Two lamellæ are separated from one another by an interspace, and are connected by perpendicular septa parallel to one another which divide the interspace into numerous tubes and smaller prismatic spaces. I leave it an open question whether this chitinous membrane is the last remains of the Gasteropod shell or a cuticular formation secreted by the superficial epithelium of the *Epizoanthus*.

The mode of life of *Epizoanthus parasiticus* is the same as that of *Epizoanthus papillosus* and *Epizoanthus cancrisocius*, the former of which was described by Gray in the Proceedings of the Zoological Society, 1867, p. 237, the latter by Studer in the Monatsberichten der Berliner Academie, Jahrg., 1878, p. 547. Both forms settle on Gasteropod shells, occupied by a hermit crab, and completely absorb the calcareous parts of the shell. The upper section of the wall of *Epizoanthus papillosus* appears to be of the same nature as that of *Epizoanthus parasiticus*. I draw this inference from Gray's words in the description given of the individual polyps, "The apex when expanded is flat, with close, radiating white lines." It is therefore still a question whether these are merely allied

species or whether *Epizoanthus papillosus* and *Epizoanthus cancrisocius* are identical with *Epizoanthus parasiticus*.

Family SPHENOPIDÆ.

Solitary Zoantheæ with the posterior end of the body rounded.

Sphenopus, Steenstrup.

Sphenopidæ with thick wall, the uppermost layers of which are encrusted with sand granules; with strong mesodermal sphincter.

Gray, in his system of the Zoantheæ (Proc. Zool. Soc., 1867, p. 236), has erected several genera, in which the individual polyps remain solitary, and are either firmly attached to the bottom or stick in the sand by means of the rounded body-end, viz., the genera *Isaurus*, *Pales*, *Orinia*, and *Sphenopus*. As no thorough anatomical studies have been made as yet of all these forms, it is doubtful in the meantime whether they ought to be placed among the Zoantheæ or not. *Sphenopus* is the only one of which I can affirm that it belongs to the Zoantheæ, as the macrosepta and microsepta are visible in regular order, and the œsophagus has only one œsophageal groove.

Sphenopus arenaceus, n. sp. (Pl. II. fig. 10, Pl. XIV. fig. 8).

The greater part of the wall is encrusted with sand granules, and so transformed into a kind of carapace; tentacles small and pointed, about sixty in number, distributed in two rows; thirty macrosepta and the same number of microsepta.

Habitat.—Cape York. (? The title of the label enclosed with the preparation was nearly entirely destroyed by the rough surface of the animal, and could not be exactly made out.) One specimen.

Dimensions.—Length, 4·5 cm.; breadth, 2·8 cm.

Colour.—(Determined from the spirit specimen) brown-red.

The wall of *Sphenopus arenaceus*, a new species, which I erect here from a single specimen among the Challenger material, is encrusted with foreign bodies to a degree which I have never found in any other Zoanthea; it forms a firm unyielding capsule, in which the soft parts are completely concealed when the animal is strongly contracted. The form of the *Sphenopus* then becomes irregularly oval, rather smaller at the rounded posterior end of the body than at the anterior. The wall is inverted a little way at the anterior end, though its nature does not undergo any change.

The surface is regularly rough like shagreen, as the sand granules are nearly all of equal size. The granules force their way so deeply into the wall that only a thin layer of soft tissue remains on the endodermal side; it is broadest in the front, and becomes narrower as it runs backwards, till the wall at the aboral body-pole consists almost entirely of

a layer of sand 5 millimetres thick (even in Pl. II. fig. 10 the soft part of the wall is too large in proportion to the layer of sand granules). Where the sand grains are absent the fundamental substance is homogeneous and furnished with two different forms of cells, small branched cells and larger roundish ones, the latter being entirely filled with strongly refractive concrement-like granules. The tissue between the sand granules (Pl. XIV. fig. 8), on the other hand, appears rather fibrous, and even the corpuscles of connective tissue are fusiform in shape. The direction of the fibres and the fusiform cells is parallel to the surface of the body. In most parts the sand granules are so thickly compacted that the fundamental substance is entirely covered.

There are no ectodermal vessels in the wall, but the supporting fibres are very numerous; they are richly furnished with granular protoplasm, are very fine and branched on the endodermal side, whilst towards the ectoderm they become lost among the sand granules.

The mesodermal circular muscle, which is strongly developed as in the other Zoantheæ, is not confined merely to the inverted part of the wall, but extends a good way down into the outer section. It is strongest where it begins close to the oral disk and lies in the non-encrusted section of the wall, it then becomes narrower and gradually approaches the endoderm, till the lower end almost touches the epithelium. It consists of bundles of fibrillæ, which give repeatedly waved figures in transverse section; several bundles are united into roundish bundles of the second order, which remain farther apart from one another.

Whilst the wall is very thick and firm, all the inner parts consist of delicate, easily torn lamellæ. The oral disk only is tolerably strong, and foreign bodies (sponge spicules, sand granules) are enclosed here and there in its supporting lamella. It is covered by a smooth layer of ectodermal radial muscles, and the margin bears two rows of tentacles; I could not determine the number of the tentacles accurately because of the strong contraction, but there were probably about sixty of them.

Before the oral disk passes into the œsophagus, which is of considerable size, it rises into a thin, sharp-margined lip, which is repeatedly indented at the edge. A large number of longitudinal ridges of the œsophagus, which correspond to the origins of the perfect septa, spring from these indentations.

The œsophageal groove is remarkably distinct; it is distinguished by its depth, and is enclosed by two broad folds, almost as hard as cartilage. Gray probably had these folds in mind when he specially mentions that in *Sphenopus marsupialis* "the laminæ of the stomach have a cartilaginous edge." They extend a little way beyond the lower margin of the stomach and form a projection, resembling the prow of a boat.

The arrangement of the septa agrees essentially with that already described in detail for *Zoanthus*, sp.? Two small directive septa lie at the dorsal end of the œsophagus, two large directive septa at the ventral end, which is easily recognised by the œsophageal

groove; two pairs, with dorsal macrosepta and ventral microsepta, adjoin the former on either side; twelve pairs, with ventral macrosepta and dorsal microsepta, adjoin the latter. The small dorsal and the large ventral septal regions are therefore separated on either side by microsepta. There are in all thirty macrosepta and thirty microsepta.

The following observations seem to me to justify these statements. From the dissection of individual septa, it was evident to me that the œsophagus is surrounded by two kinds of septa, viz., macrosepta, which are attached along the entire length of the œsophagus; and microsepta, which end on the oral disk before it becomes raised into the oral lip. In all of them the muscular fibres which rise obliquely are very distinct, the longitudinal fibres less so.

The only example of *Sphenopus arenaceus* which I was able to examine was bisected longitudinally parallel to the sagittal plane, so that only the one half (Pl. II. fig. 10) contained the œsophageal groove and the septa fastened to it. At the end of the œsophageal groove three macrosepta followed one another before I liberated the first microseptum by dissection, whilst the adjoining part of the other half begins with a microseptum, and the macrosepta and microsepta come alternately. If we then compare the transverse section through *Zoanthus* (Pl. XIV. fig. 3), we find a similar arragement of the septa in the region of the œsophageal groove, except that in *Sphenopus* the outermost of the four macrosepta placed in a row in *Zoanthus* is wanting. As it falls in the line through which the section has been taken in dividing the animal, it has most likely been destroyed.

At the dorsal end we first meet with a microseptum, then with a macroseptum; after which, on dissection, I found the septa arranged in the following order, two microsepta, one macroseptum, one microseptum, one macroseptum, one microseptum, one macroseptum. In the adjoining portion of the other half, I found one microseptum, one macroseptum, one microseptum, one macroseptum, two microsepta, one macroseptum. If we compare this arrangement with fig. 3 of *Zoanthus*, and consider the two pairs of microsepta discovered by dissection to be homologous with the two lateral pairs of microsepta in *Zoanthus*, we should likewise meet with the same corresponding conditions if we assume that one of the small directive septa and the adjoining macroseptum have been destroyed in making the section.

Finally, as regards the number of the septa, I determined them according to the lines of insertion which shone through the œsophagus; in this way we can settle the number of the macrosepta, with which the number of microsepta corresponds, presupposing, of course, that they are arranged in the same way as in *Zoanthus*. I found this to be the case in at least half of the septa dissected.

The reproductive organs and mesenteric filaments were cemented by mucus into a badly preserved mass, and were not adapted for examination.

Tribe VI. CERIANTHEÆ.

Actiniaria with numerous unpaired septa and a single ventral œsophageal groove; the septa are longest on the ventral side and gradually diminish towards the dorsal aspect; the two septa attached to the bottom of the œsophageal groove (directive septa) are remarkably small, and are distinguished in this way from the other ventral septa.

I have made no further anatomical investigations of the Ceriantheæ, and cannot even complete the statements which were formerly made by von Heider (Sitzungber. d. Wiener Akad. Math. Naturw. Cl., Bd. lxxix. Abth. 1, p. 204, Jahrg., 1879), and my brother and myself (Actinien, p. 107). From these we cannot even certainly determine what position the animals occupy in the circle of the Actiniaria, and whether or not they ought to be placed in one of the known principal divisions. They are distinguished from all the forms previously discussed, except the Edwardsiæ, by the fact that they want the paired arrangement of the septa—at least up to the present it has not been observed in them. They come nearest the Zoantheæ, as they have only one œsophageal groove; the septa also appear not to be disposed in a circle, but in the region of a limited zone of growth, which, however, lies dorsally, not ventrally as in the Zoantheæ. In this case the largest septa are found in the region of the œsophageal groove, and the septa gradually decrease in size from that point to the opposite end of the sagittal axis; two pairs of very small septa lie under the œsophageal groove; to which the name of directive septa is given more from their position than from their anatomical constitution.

Family CERIANTHIDÆ.

Ceriantheæ with a double corona of tentacles, marginal principal tentacles and circumoral accessory tentacles, posterior end of the body rounded, without sphincter.

Cerianthus, Delle Chiaje.

Cerianthidæ with aboral pore, with a sheath consisting of mud, sand granules, and nematocysts, in which the posterior end of the animal lies as if in a case.

Cerianthus americanus.

Cerianthus americanus, Verrill, Memoirs Boston Soc., vol. i. p. 32, 1866.

Habitat.—Station 321. February 25, 1876. Lat. 35° 2′ S., long. 55° 15′ W. Depth, 13 fathoms. One specimen.

Dimensions.—Length of the animal (in the contracted condition), 12 cm.; breadth of the oral disk, 3·5 cm.; length of the inner tentacles, 2–2·5 cm.; of the outer tentacles, 4–5 cm.

Most species of the genus *Cerianthus* are far surpassed in size by *Cerianthus americanus*, which Verrill only has hitherto described. His account of it is as follows: "Column very long, cylindrical, expanded at the top, tapering gradually below; in expansion, often two feet or more long, in contraction, six or eight inches. Body enclosed in a loosely investing tube, buried in the mud. Tentacles long and numerous, the outer series (125 or more) are from 1·25 to 1·50 inches long, slender, very flexile, usually much curled at the ends; inner series similar, about ·75 long, nearly the same as the former in appearance; often brought together and spirally twisted in a central bundle. Base with a small but distinct opening.

"Color of column dark cinnamon-brown, lined longitudinally with a lighter tint of the same; outer tentacles cinnamon-brown, lighter at the bases; inner series darker, marked with white longitudinal lines; disk bright yellow, the central portion brown; at the bases of the tentacles spotted with dark brown."

I consider the single specimen of the genus *Cerianthus* dredged by the Challenger as identical with *Cerianthus americanus*. As it is more than 12 cm. long, it may easily have measured more than 50 cm. when alive. The number of the outer tentacles, which I reckoned at about two hundred, is larger than in the specimens examined by Verrill, whilst their length is about the same. The distribution of colour on the tentacles was no longer recognisable, as the whole colour of the animal had been changed by the spirit. I did not attempt an anatomical examination, as I did not wish to destroy the unique specimen.

APPENDIX.

By way of appendix I shall describe some forms whose systematic position I was unable to determine, as their state of preservation did not admit of an anatomical investigation of the inner parts, especially of the septa.

Two of them seemed to me to be closely related and to belong to the same genus *Porponia*, and I shall discuss them in detail as interesting species, though I have not done so in the case of the others.

Porponia, n. gen.

Actiniaria (Hexactiniæ ?) with two œsophageal grooves, without circular muscle, with thin-walled tentacles, the bases of which are supported on the outer side by clasp-like prolongations of the wall.

Porponia elongata, n. sp. (Pl. I. figs. 1, 2).

Body elongated, sessile, wall cartilage-like, small, upper end terminated by twenty-seven knobs forming supporting clasps for the outer sides of the same number of long, thin-walled tentacles; twenty-seven additional tentacles placed in an inner second row, and alternating with the outer tentacles.

Habitat.—Station 160. March 13, 1874. Lat. 42° 42′ S., long. 134° 10′ E. Depth, 2600 fathoms. Two specimens.

Dimensions.—Height, 5·5 cm.; breadth of the base, 2·5–3·5 cm.; breadth of the oral disk, 3·0–4·0 cm.; length of the tentacles, 1·5–2·5 cm.

Whilst the majority of Actiniæ, especially those from great depths, form a short column, and are frequently flattened into a disk, the body form of *Porponia elongata*, a new species taken from a depth of 2600 fathoms, approximates that of the elongated Cerianthidæ. In both specimens examined the body, though contracted, was twice as long as high. It is broadest in the region of the oral disk, below which it becomes a little narrower, and then becomes broader again at the pedal disk, by which it is firmly attached to the bottom. It was impossible to recognise the original colour of the animal, but this was partly owing to the fact that the ectoderm was completely macerated away.

The pedal disk is thin and the insertions of the septa shine through it as whitish, radial lines. There are altogether about thirty-two to thirty-four such lines, some of which, however, only project a little way towards the centre of the pedal disk. Setting

these aside, we can count in both cases twenty-eight almost equally distinct lines, which appear to be grouped in pairs.

Contrasted with the pedal disk the wall is very thick, as it measures 2–3 mm. in transverse section, and by reason of its cartilaginous hardness forms at the same time a most powerful protection for the parts covered by it. The surface is smooth and only traversed here and there by furrows, which may, however, be absent in the living animal; the upper margin ends in pointed knobs which project like battlements above the enclosed oral disk. The number of the knobs appears to be constant, as it amounted to twenty-seven in both the larger and the smaller specimen examined, though they differed in size. The larger and smaller knobs are placed irregularly, so that sometimes both kinds alternate, sometimes several knobs of the same size lie beside one another.

The oral disk, which springs from the wall at the base of the knobs, is as thin as tissue paper and correspondingly transparent. Numerous (probably fifty-four) white radial streaks denote the insertions of the underlying septa.

The tentacles, like the oral disk, are very thin-walled and delicate, and are 1·5–2·5 cm. long. The base is of medium breadth; they then diminish rapidly in size, and run out into a long fine point, through which even pressure cannot expel the contents of the tentacles, thus showing the absence of the terminal opening common to many Actiniæ. They are placed in two alternating rows of twenty-seven tentacles each. The outer tentacles spring immediately on the inside of the twenty-seven knobs of the wall, which may therefore be regarded as clasp-like thickenings of their basal sections; the inner tentacles alternate with the outer, and are placed so close to them that their bases are partially inserted into the interspaces between the outer tentacles.

The oral disk is covered by a thin ectodermal slightly pleated layer of radial muscular fibres, which extend as longitudinal fibres into the tentacles; in many places it had fallen away along with the epithelium lying above it. There were still fewer of the circular endodermal muscular fibres preserved.

The oral angle and the œsophageal grooves are very distinct in the oral fissure and the œsophagus. The œsophageal grooves are only a little longer than the rest of the œsophagus, but on the other hand they are of considerable breadth, and occupy about two-fifths of the whole extent of the œsophagus. The side walls of the grooves are repeatedly folded in a transverse direction. Longitudinal folds, nine in the one case, eleven in the other, which begin with the same number of knobs at the margin of the oral fissure, run on the two intermediate portions of the œsophageal wall. The oral margin itself projects as a ridge, just as the oral disk in *Sphenopus arenaceus* is very much raised before it passes at an acute angle into the œsophagus.

There are, altogether, twenty-eight septa inserted into the œsophagus—veil-like, extremely delicate, easily torn membranes, never pierced by septal stomata. It was impossible to arrive at any decided opinion as to their structure and arrangement, both

specimens having been badly preserved. As both the ectodermal epithelium and muscles were almost entirely macerated away, so also all the endodermal parts formed a disintegrated mass in the radial chambers. The muscles of the septa were nowhere preserved, so that I could only form an idea of their course from the furrows on the surface of the supporting lamellæ. These were, however, not very distinct, as the muscles of the septa, like the muscles of all the other organs, are extremely weakly developed; as far as I could make out each septum bears longitudinal muscles on the one side, and transverse muscles on the other, as in other Actiniæ.

All the septa are furnished in the section below the œsophagus with reproductive organs which reach like long, broad, folded bands almost as far as the pedal disk, but the mesenteric filaments were macerated away and nowhere to be found.

Besides the twenty-eight perfect septa there are imperfect septa, which only reach as far as the middle of the oral disk, and do not bear reproductive organs. I did not determine the number of them by direct observation, as in order to do this I should have been obliged to dissect the entire animal, and I could not make up my mind to this, considering how insufficiently it was preserved. I estimate them at twenty-six, as in the majority of Actiniaria the aggregate number of the tentacles nearly corresponds to that of the septa.

Though the anatomical description here given is but deficient, I consider myself justified in regarding *Porponia elongata* as a form systematically interesting. The position of the tentacles in a double row, the presence of perfect reproductive septa (macrosepta) and imperfect sterile septa (microsepta) are characteristics which recall the Zoantheæ; the numbers of the tentacles and the septa likewise agree with those of this group, as they are neither multiples of the number six, as in the Hexactiniæ, nor of the number four, as in the Paractiniæ. On the other hand, having two œsophageal grooves, *Porponia elongata* comes closer to the Hexactiniæ, among which, as I have already specially observed (p. 30), it most resembles the Antheomorphidæ. I therefore consider it most likely that *Porponia elongata* is an intermediate form between the Hexactiniæ and the Zoantheæ.

Porponia robusta (Pl. I. fig. 10).

Body compressed, as high as broad, sessile; wall tough, the upper end prolonged into numerous scimitar-shaped processes, which support the outer walls of the long, thin-walled saccular tentacles.

Habitat.—Station 237. June 17, 1875. Lat. 34° 37′ N., long. 140° 32′ E. Depth, 1875 fathoms. One specimen.

Dimensions.—Height, 4 cm.; breadth of the oral disk, 4 cm.; breadth of the pedal disk, 3 cm.

The single specimen of *Porponia robusta* had unfortunately been preserved in chromic acid, and had therefore become so brittle that I must confine myself to a description of the external form of the body. The animal is shaped like a short,

compressed cylinder; it becomes a little broader towards the pedal disk, but very markedly so in the upper half, so that the margin of the oral disk is turned outwards even when the animal is fully contracted.

The pedal disk and oral disk are thin-walled, but the wall itself is of considerable thickness; its upper surface is smooth, for though there are oblique and longitudinal wrinkles and furrows they are plainly owing to contraction. There is no circular muscle, as may be gathered from the form of the anterior end of the body. A single row of tentacles stands on the margin between the oral disk and wall; they look like long, wide, thin, membraned sacs, and do not become smaller at the ends. A firm clasp, quite 1 cm. long, runs on the outer wall of the tentacles, as a prolongation of the body-wall; it is broadest and thickest at the base, and gradually becomes narrower and thinner towards the end. As the tentacles, in consequence of contraction, are turned over towards the oral disk, the tentacle clasps are also bent inwards like a scimitar, many of them so much so that they lie obliquely above the oral disk. I was unable to determine the exact number of the tentacles, as they were bent confusedly over one another, and the friable nature of their clasps prevented me from trying to separate them. They amounted, however, to more than forty.

Besides the longitudinal ridges, I found two œsophageal grooves on the œsophagus, one of them much more strongly developed than the other. After I had removed the pedal disk by a horizontal section, I was able to count the septa, of which there were thirty-eight, separated from one another by interspaces of equal size. They appeared to me all to bear reproductive organs, but only to extend partially to the œsophagus. They also projected more or less towards the centre of the pedal disk.

In this appendix I have still three forms of Actiniæ to consider besides the *Porponiæ*. The first was taken at Tristan da Cunha, at a depth of 1000 fathoms, and appears to be a *Phellia*. The body, 1·3 cm. long and 1·0 cm. broad, is covered with a finely granulated, brownish, leather-like cuticle, which is wanting on the short inverted part of the wall. A strong circular muscle, which contracts the wall to such an extent that the entrance to the oral disk is completely closed, lies in the inverted portion of the wall. I can say nothing as to the number of the very small tentacles, and I was also unable to examine the number and nature of the septa more minutely.

The two other forms of Actiniæ were taken along with the four specimens of *Cereus spinosus* and the single specimen of *Porponia robusta*, at a depth of 1875 fathoms, on June 17, 1875, at station 237 (lat. 34° 37′ N., long. 140° 32′ E.); like the Actiniæ just mentioned, they had been placed in chromic acid, and were therefore but little adapted for examination.

In the one instance I had to do with an Actinia, which so strongly resembled the *Dysactis crassicornis* described on page 44, that I was long inclined to consider it as the same species. As in *Dysactis crassicornis*, the muscles on the oral disk and

tentacles are mesodermal; the strong sphincter, which is also enclosed in the mesoderm, lies close under the endoderm, and contracts the wall so strongly that the surface becomes arranged in ridge-like, projecting folds. The tentacles only are different; they are placed in four alternating rows, are equal to one another in size, and are much longer and more powerful than in *Dysactis crassicornis*, so that even when contracted they form slightly curved horns 3 cm. long. The most striking point, however, is the wide, gaping opening at the free end, from which one might give the animal the specific name *tubulifera*. This Actinia probably belongs to the genus *Paractis*, the smooth surface of the wall, the mesodermal circular muscle, and the equality of size in the tentacles of the individual rows being common to both. The two specimens of this Actinia before me are both 3 cm. high and 6 cm. broad at the pedal disk; they become smaller towards the upper end, the diameter of which only amounts to 2·5 cm.

The last Actinia to be considered belongs to the forms in which the tentacles have undergone retrograde formation, on account of which I have named it *Liponema multiporum*. The only specimen of it was hardened in chromic acid and also greatly injured, a combination most unfavourable for examination. The pedal disk and the lower part of the wall were torn, the œsophagus forcibly protruded and also torn, so that the oral disk was stretched and misplaced; it formed the side walls of the body, and this led me at first to take it for the wall and the wall for the pedal disk, till I discovered my mistake in examining it histologically.

The oral disk is devoid of freely moving tentacles, but has instead numerous, small stomidia, roundish openings not measuring more than 2 mm. in diameter. The tentacles in *Liponema multiporum* have undergone retrograde formation to a greater extent than in any other Actinia, as there are not the smallest remains of their walls, while in *Polyopis* these can still be recognised as thickened ridges surrounding the openings (Pl. XIV. fig. 7).

Part of the stomidia, which number several hundreds, are arranged on the margin of the oral disk in a repeatedly waved circle, the remainder lie at short distances from one another on the oral disk, on which they are distributed nearly to the oral opening. After dissecting a number of septa I became convinced that more than one stomidium communicates with each radial chamber; in fact, I believe that the marginal openings must be considered principal stomidia, the others accessory stomidia. We therefore have here the same conditions as in the Discosomidæ and Corallimorphidæ, if we consider the tentacles to be replaced by the stomidia. The oral disk is covered with numerous fine ridges which wind between the accessory stomidia and so have a very sinuous course. The radial muscles are ectodermal and borne by fine supporting folds, having the same constitution as in *Cerianthus*. I have also examined the circular muscular system of the wall; I found it thickly pleated in the whole upper region of the wall, especially in the part adjoining the oral disk, where it formed a kind of sphincter. The pleating ceases rather suddenly at the outer margin of the principal stomidia. The

muscular folds of the layer of circular muscles are very long, and thickly branched only at the base, so that a principal fold soon becomes divided into numerous parallel secondary folds.

SURVEY OF THE ACTINIÆ EXAMINED.

Family.	Genus.	Species.	Depth in Fathoms.	Station.	Habitat.	If New		Number of Specimens.
						Species.	Genus.	
Corallimorphidæ	*Corallimorphus*	*profundus*	2025	293	39° S. 105° W.	n. sp.	n. g.	1
,,	,,	,,	1375	300	33° S. 78° W.	n. sp.	n. g.	1
,,	,,	*rigidus*	1375	146	46° S. 45° E.	n. sp.	n. g.	3
,,	,,	,,	1950	157	53° S. 108° E.	n. sp.	n. g.	1
,,	,,	,,	1425	195	4° S. 129° E.	n. sp.	n. g.	1
Antheomorphidæ	*Antheomorphe*	*elegans*	2900	244	35° N. 169° E.	n. sp.	n. g.	3
Antheadæ	*Comactis*	*flagellifera*	25	...	30° S. 20° E.	...	...	1
Tealidæ	*Tealia*	*bunodiformis*	Shore.	...	37° S. 12° W.	n. sp.	...	3
,,	*Leiotealia*	*nymphæa*	120	149	49° S. 70° E.	...	...	1
Paractidæ	*Dysactis*	*crassicornis*	10	312	53° S. 70° W.	n. sp.	...	1
,,	,,	,,	55	313	52° S. 68° W.	n. sp.	...	4
,,	,,	*rhodora*	55	313	52° S. 68° W.	...	...	2
,,	*Paractis*	*tubulifera*	1875	237	34° N. 140° E.	n. sp.	...	2
,,	,,	*excavata*	1375	300	33° S. 78° W.	n. sp.	...	1
,,	*Tealidium*	*cingulatum*	1800	158	50° S. 123° E.	n. sp.	...	1
,,	*Antholoba*	*reticulata*	55	313	52° S. 68° W.	...	...	3
,,	*Ophiodiscus*	*annulatus*	2160	299	33° S. 74° W.	n. sp.	n. g.	4
,,	,,	*sulcatus*	1375	300	33° S. 78° W.	n. sp.	n. g.	1
Liponemidæ	*Polysiphonia*	*tuberosa*	565	235	34° N. 138° E.	n. sp.	n. g.	20
,,	*Polystomidium*	*patens*	1825	296	38° S. 88° W.	n. sp.	n. g.	1
,,	*Liponema*	*multiporum*	1875	237	34° N. 140° E.	n. sp.	n. g.	1
Sagartidæ	*Sagartia*	sp. (?)	360	194	4° S. 129° E.	...	...	1
,,	*Calliactis*	*polypus*	18	208	11° N. 123° E.	...	...	3
,,	,,	,,	...	...	17° N. 27° W.	...	...	6
,,	*Cereus*	*spinosus*	1950	157	53° S. 108° E.	n. sp.	...	1
,,	,,	,,	1875	237	34° N. 140° E.	n. sp.	...	4
,,	*Phellia*	*pectinata*	147	307	49° S. 74° W.	n. sp.	...	1
,,	,,	sp. (?)	1000	...	...	?	...	1
,,	*Bunodes*	*minuta*	1600	147	46° S. 48° E.	n. sp.	...	1
Amphianthidæ	*Stephanactis*	*tuberculata*	345	232	35° N. 139° E.	n. sp.	n. g.	1
,,	,,	*abyssicola*	1350	46	40° N. 66° W.	n. sp.	n. g.	2
,,	*Amphianthus*	*bathybium*	2300	241	35° N. 157° E.	n. sp.	n. g.	1
Ilyanthidæ	*Halcampa*	*clavus*	25	149	49° S. 70° E.	...	...	2
,,	,,	,,	120	149	,,	...	...	1
Sicyonidæ	*Sicyonis*	*crassa*	1600	147	46° S. 48° E.	n. sp.	n. g	1
Polyopidæ	*Polyopis*	*striata*	2160	299	33° S. 74° W.	n. sp.	n. g.	1
Monaulidæ	*Scytophorus*	*striatus*	150	150	52° S. 71° E.	n. sp.	n. g.	2
Zoanthidæ	*Zoanthus*	sp. (?)	...	...	...	...	...	1
,,	*Epizoanthus*	*parasiticus*	565	235	34° N. 138° E.	...	...	2
Sphenopidæ	*Sphenopus*	*arenaceus*	...	...	...	n. sp.	...	1
Cerianthidæ	*Cerianthus*	*americanus*	13	321	35° S. 55° W.	...	...	1
...	*Porponia*	*elongata*	2600	160	42° S. 134° E.	n. sp.	n. g.	2
...	,,	*robusta*	1875	237	34° N. 140° E.	n. sp.	n. g.	1

NOTE.—The reader is reminded that this is not a complete list of the Challenger Actiniæ. A number of specimens, which did not reach Professor Hertwig till after this Memoir was in type, will be described in a Supplementary Report.—J. M.

Concluding Remarks.

In the Introduction I have given a sketch of the structure of the Actiniaria, and also at the same time a short summary of the most important morphological results furnished by the Challenger material; all that remains is for me to discuss how far the results of the Challenger expedition have furthered our knowledge of the manner in which the group in question is distributed. I have therefore made out a tabular survey (p. 130) of the Actiniæ described and their habitats, and have also stated whether or not they are new species and genera. It follows, of course, that I have only enumerated as new, such species as have been actually described for the first time by Moseley and myself, whilst I have included among the known animals those forms to which, since we know their anatomy more thoroughly, it has been necessary to give new names, especially new generic names.

The table in question gives no determinate results as to the geographical distribution of the animals; it was, indeed, evident from the first that the Challenger material was neither sufficient nor suitable for this purpose. The number of hauls made by the dredge was utterly disproportioned to the vast tracts traversed by the ship in her voyage round the world; the individual faunatic regions especially have been very irregularly examined. As the ship was mostly on the high seas, the coasts, which would have furnished the richest spoils, were of necessity almost entirely neglected, and in this way we only find one littoral species in the list.

On the other hand, we must take into special consideration the manner in which the Actiniæ are distributed in the different depths of sea. How far is the number of the Actiniæ diminished by the increase of the depth? How far does the deep-sea fauna vary from the fauna of the coasts and the shallows? Has life in the depths exercised, as in other cases, a visible influence on the organisation of the animal? These are questions which may be partially solved from the tolerably wide range of material furnished by the Challenger collection.

As a rule the number of the Actiniæ decreases as the depth increases; up to the present they have not been observed even in the Challenger expedition at a depth of over 2900 fathoms, though the decrease does not take place so rapidly as might be expected. In proof of this I contrast the results given by the hauls with the dredge in 10–500 fathoms, with those in 500–2900 fathoms. The net was let down ninety-seven times in depths of 10–500 fathoms, and eleven times with some result, *i.e.*, with the capture of some twenty specimens distributed over thirteen different species. There were one hundred and sixty-five hauls with the dredge at depths of 500–2900 fathoms, fourteen of these furnished about sixty specimens, representing twenty-one different species. These numbers cannot of course be compared off hand, as the hauls made by the dredge in great depths

lasted much longer, and consequently extended over a larger tract, but at the same time we can see from this that the deep-sea Actiniæ are by no means exceptionally rare.

The relative abundance of the Actiniæ among the deep-sea fauna is shown by the fact that several species and several specimens of the same species were not unfrequently found at the same station. Station 235 furnished the largest number of individuals, viz., twenty specimens of *Polysiphonia tuberosa* and two colonies of *Epizoanthus parasiticus* were taken at a depth of 565 fathoms. Stations 237 and 300 were distinguished by the diversity of the forms dredged; at the former four specimens of *Cereus spinosus*, two of *Paractis tubulifera*, one of *Porponia robusta*, and one of *Liponema multiporum* were taken at a depth of 1875 fathoms, at the latter one *Corallimorphus profundus*, one *Paractis excavata* and one *Ophiodiscus sulcatus* were taken at 1375 fathoms. The following stations yielded also good results:—Station 299; depth, 2160 fathoms; one *Ophiodiscus annulatus* and one *Polyopis striata*. Station 157; depth, 1950 fathoms; one *Cereus spinosus* and one *Corallimorphus rigidus*. Station 147; depth, 1600 fathoms; one *Bunodes minuta* and one *Sicyonis crassa*.

The stations in shallow water are far behind as regards the results of the dredgings. The only stations worthy of special mention are Station 143, depth 120 fathoms, which contributed two *Halcampa clavus* and one *Leiotealia nymphæa* to the Challenger material; and Station 313, depth 55 fathoms, which contributed three *Antholoba reticulata*, four *Dysactis crassicornis*, and two *Dysactis rhodora*.

As regards the relation in which the fauna of the different depths stand to one another, it may already be safely asserted that the greater the depth, the more the fauna varies from that of the coast. I will make only two divisions, and compare, on the one hand, the Actiniæ from 10–500 fathoms, and on the other, the Actiniæ from 500–2900 fathoms with the known forms essentially belonging to the coast. The first region gives on the whole thirteen species and twelve genera, of which five species and two genera (*Scytophorus* and *Stephanactis*) are new. The remaining twenty-one species and seventeen genera belong to the second region (two genera, *Phellia* and *Stephanactis*, are represented in both divisions), of which not less than twenty species and eleven genera are new. The depths of 500–3000 fathoms are therefore inhabited by entirely different Actiniæ, as even the only species which cannot be considered as new, *Epizoanthus parasiticus*, approached the first region, as it was taken at a depth of 565 fathoms.

The varying character of the deep-sea fauna leads us to the third question already started, viz., has life in the great depths a visible influence on the organisation of the Actiniæ? This influence can be distinctly recognised in many forms, and is shown by the nature of the tentacles which have undergone retrograde formation, and are transformed first into tubes, and afterwards into simple openings in the oral disk. In *Paractis tubulifera* (depth 1875 fathoms) the tentacles have the same constitution as in the majority of Actiniæ, except in one point, that the terminal opening, which is usually

small or entirely wanting, gapes widely. In *Polysiphonia tuberosa* (565 fathoms) the tentacles have become short, slightly movable, wide-mouthed tubes; in *Sicyonis crassa* (1600 fathoms) they are small, wart-like rings, and in *Polystomidium patens* (1825 fathoms) and *Polyopis striata* (2160 fathoms) the walls have almost entirely disappeared, so that the terminal opening forms a fissure in the oral disk, the last remains of the tentacle being represented by a circular margin surrounding the fissure, and so we come finally to the genus *Liponema* (1875 fathoms), in which the points at which the tentacles were actually placed are merely indicated by openings in the oral disk. Of the twenty-one forms from 500–3000 fathoms here described, no less than six species have therefore undergone modifications of the tentacles in the same sense, whilst it has never been observed in a single one of the forms of the coast fauna, which greatly exceed the deep-sea fauna in number.

The view that the retrograde formation of the tentacles is connected with life in greater depths is not only supported by the fact observed, that the character is limited in its distribution to the deep-sea Actiniæ, but also by the way in which it appears in the different groups of Actiniæ. The six forms named in the last paragraph show conditions allied to those in families of Actiniæ lying widely apart from one another. Of the three genera united as Liponemidæ, *Liponema* comes near the Discosomidæ, as its stomidia may be divided into principal and accessory stomidia; *Polystomidium patens* resembles the Antheadæ in having an endodermal muscle and marginal spherules, and *Polysiphonia* with its mesodermal circular muscle resembles the Paractidæ, to which *Paractis tubulifera* undeniably belongs. It might therefore perhaps be advisable to do away with the family Liponemidæ, and to distribute its members among the Discosomidæ, Antheadæ, and Paractidæ. Finally, *Sicyonis crassa* and *Polyopis striata* vary entirely from other Actiniæ, and are at the same time forms which differ entirely one from another. It is most probable that a character which appears in forms which vary so remarkably, but exist under the same conditions, is the consequence of these conditions of existence.

There is another point in the mode of life of the deep-sea Actiniæ which seems to me to favour the transformation of the tentacles into tubes and openings. The nutriment of the deep-sea animals probably consists chiefly of material which is already disintegrated, and of a soft nature when obtained. The animals often ingest sand, impregnated with nutriment, from which they extract what is digestible; at least I have repeatedly found the interior of the deep-sea Actiniæ full of mud. In such a mode of nutrition the long prehensile tentacles would not be of the same use as they are in the littoral Actiniæ, which lie in wait for booty, whilst on the other hand it would be a decided advantage to the animals to be furnished with numerous inhalent tubes and openings through which they can absorb semi-liquid nourishment. This then is the advantage of the stomidia and tubular tentacles.

The retrograde formation of the tentacles is by no means the only point to be taken

into consideration in the varying character of the deep-sea Actiniæ, the position of the septa being equally important. The arrangement of the septa typical of the Hexactiniæ is only present in thirteen genera, among which I reckon *Ophiodiscus* and *Polystomidium*, in which we meet with the differentiation of muscular and genital septa which is otherwise unknown, and the genera *Stephanactis* and *Amphianthus*, in which we find some approach to the Antipatharia. The other four genera differ from one another as well as from the Hexactiniæ in the arrangement of the septa. They swell the number of the varying forms represented in shallow water by the Zoantheæ, Ceriantheæ, and Edwardsiæ, and therefore seem to indicate that the diversity in the structure of the Anthozoa was formerly much greater than it is at present, and that the remains of this diversity have been more extensively preserved in the depths of the sea than in the shallow waters. In this way we can recognise peculiarities in deep-sea Actiniæ which are common to the whole deep-sea fauna.

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PLATE I.

PLATE I.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c[1] Perioral stomata.
c[2] Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml[1] Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p[1] Process of the ovicell.
p[2] Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t[1] Principal tentacles.
t[2] Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a[1]	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

All the figures are of natural size.

Fig. 1. *Porponia elongata.*

Fig. 2. *Porponia elongata,* opened by a longitudinal incision; and the pedal disk split up by repeated radial incisions. In the lettering on the plate for *so* read *sr*.

Fig. 3. *Cereus spinosus.*

Fig. 4. *Cereus spinosus;* the half of a sextant prepared by cutting into separate pieces; in the left-hand portion one of the principal septa (h^1) reaching to the œsophagus, with mesenteric filament and acontia but without reproductive organs; then follow a pair of septa of the fourth order (h^4) and a pair of septa of the third order (h^3). The right-hand portion begins with the next following pair of small septa of the fourth order (h^4), and the much larger pair of septa of the second order (h^2). All the accessory septa have mesenteric filaments, acontia and reproductive organs, but do not reach the œsophagus which hangs over them like an apron. A portion of the œsophagus has been removed in the left-hand portion. Only the septa of the second order have coiled mesenteric filaments like the principal septa. The three tentacles of the first row (t^1) belong to the pairs of septa of the first to the third order, the two of the second row (t^2) to the pairs of septa of the fourth order, the four of the third row (t^3) to the interseptal spaces.

Fig. 5. *Cereus spinosus,* opened by a longitudinal incision, which has run between a septum of the third and a septum of the fourth order. The principal septa (h^1) project with their coiled mesenteric filaments below the lower margin of the œsophagus; the septa of the second order (h^2) project with smooth edges as their coiled mesenteric filaments, and their reproductive organs are covered by the œsophagus; the septa of the third order (h^3) project with their reproductive organs. The septa of the fourth order (h^4) are only visible at the side.

Fig. 6. *Paractis excavata,* one-third of the animal has been cut out in order to show the arrangement of the oral disk and the corona of tentacles; the section is directed so as to show two principal septa.

Fig. 7. *Phellia pectinata,* opened longitudinally; the section runs between two principal septa of the same pair; the principal septa project with their coiled mesenteric filaments below the œsophagus.

Fig. 8. *Antheomorphe elegans.*

Fig. 9. *Antholoba reticulata.*

Fig. 10. *Porponia robusta;* fig. 10, *a*, a separate tentacle.

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Lith. Anst. v. Werner & Winter Frankfurt a/M.

PLATE II.

PLATE II.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c[1] Perioral stomata.
c[2] Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml[1] Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p[1] Process of the ovicell.
p[2] Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t[1] Principal tentacles.
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v Openings of the pedal disk.

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	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a[1]	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Fig. 1. *Corallimorphus rigidus,* seen from the oral disk; one half the natural size.

Fig. 2. *Corallimorphus profundus,* seen from the pedal disk; one half the natural size.

Fig. 3. ,, ,, seen from the oral disk; one half the natural size.

Fig. 4. Lateral view of a portion of *Corallimorphus rigidus;* natural size.

Fig. 5. Half of the pedal disk of *Corallimorphus rigidus;* natural size.

Fig. 6. A septum with two tentacles, running out from the corresponding intraseptal space; seen from the side of the intraseptal space.

Fig. 7. *Polysiphonia tuberosa,* lateral view; natural size.

Fig. 8. *Polysiphonia tuberosa,* a part of the margin of the oral disk, the tentacles having been cut away at their bases.

Fig. 9. *Polysiphonia tuberosa,* seen from the oral disk.

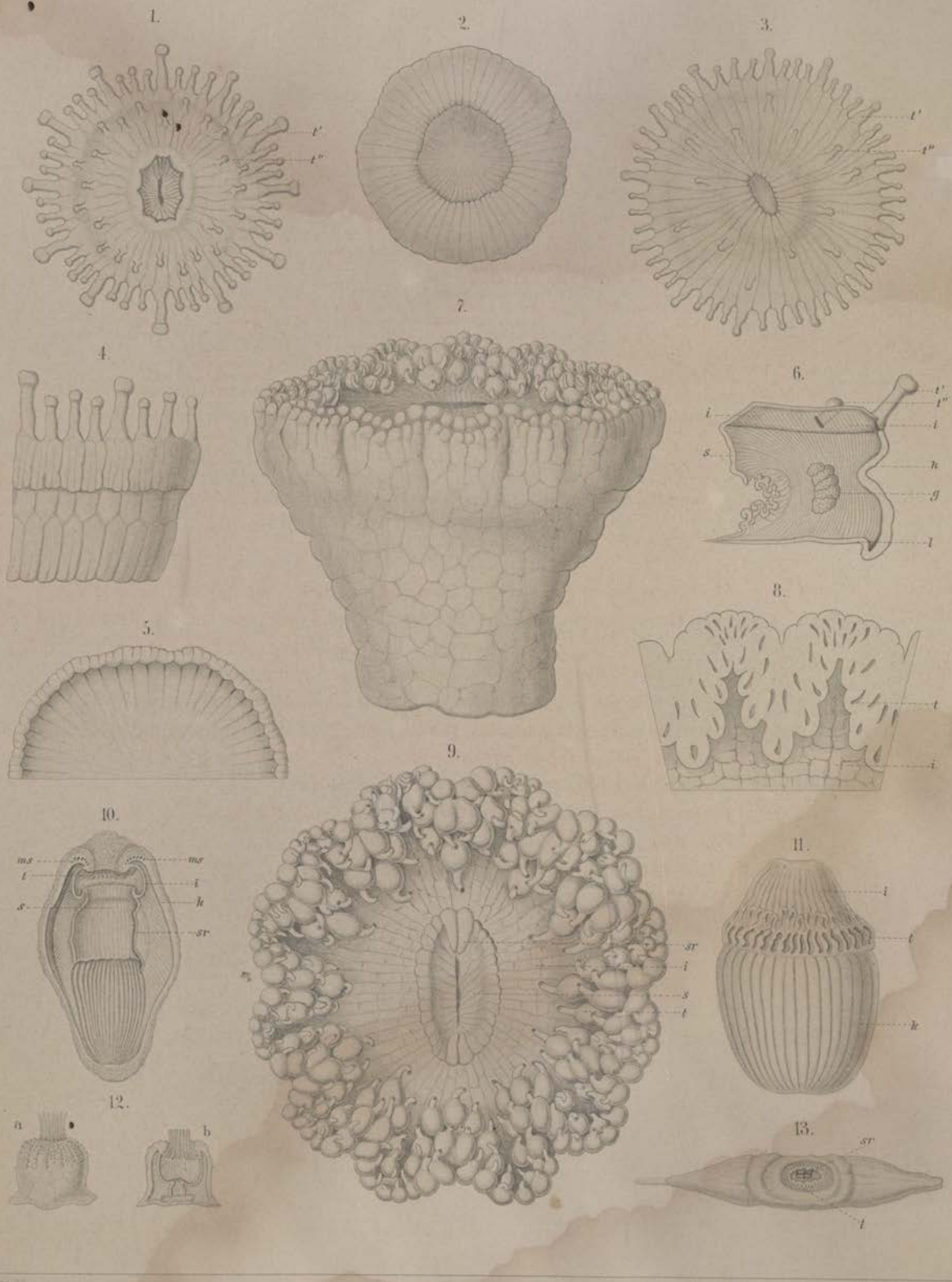
Fig. 10. *Sphenopus arenaceus,* bisected longitudinally; natural size. (By an oversight the microseptum has been omitted on the left-hand side.)

Fig. 11. *Polyopis striata,* twice the natural size.

Fig. 12, *a*. *Bunodes minuta,* natural size.

Fig. 12, *b*. *Bunodes minuta,* bisected longitudinally.

Fig. 13. *Stephanactis abyssicola,* one and a half times the natural size; seen from the oral disk.



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E. A. Funke Leipzig, Lithogr.

PLATE III.

PLATE III.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c[1] Perioral stomata.
c[2] Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml[1] Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p[1] Process of the ovicell.
p[2] Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t[1] Principal tentacles.
t[2] Accessory tentacles.
v Openings of the pedal disk.

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A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Fig. 1. *Halcampa clavus*, bisected longitudinally so that the plane of division has opened two intraseptal spaces; twice the natural size.

Fig. 1, *a*. Half of the upper end of the body seen from the oral side; tentacles bent inwards; twice the natural size.

Fig. 1, *b*. Upper end of the body with expanded tentacles; twice the natural size.

Fig. 2. *Epizoanthus parasiticus;* natural size.

Fig. 3. *Tealidium cingulatum*, in a contracted condition, seen from the upper end of the body; twice the natural size.

Fig. 4. *Halcampa clavus;* natural size.

Fig. 5. *Comactis flagellifera;* twice the natural size.

Fig. 6. *Scytophorus striatus;* natural size.

Fig. 7. *Stephanactis tuberculata*, lateral view; natural size.

Fig. 7, *a*. *Stephanactis tuberculata*, from the oral side; natural size.

Fig. 7, *b*. *Stephanactis tuberculata*, lateral portion of the body with the œsophageal groove.

Fig. 8. *Ophiodiscus sulcatus;* natural size; greatly restored.

Fig. 9. A colony of *Epizoanthus parasiticus*, divided longitudinally; natural size.

Fig. 10. Pedal disk of *Halcampa clavus* detached and seen from the inside. A, Oc. 1.

Fig. 11. *Amphianthus bathybium*, seen from the surface; natural size.

Fig. 11, *a*. *Amphianthus bathybium*, a piece of the wall; slightly enlarged.

Fig. 11, *b*. *Amphianthus bathybium*, the margins of the pedal disk enclosing the *Mopsea;* slightly enlarged.

Fig. 11, *c*. *Amphianthus bathybium*, lateral view; natural size.

Fig. 12. Individual of a colony of *Epizoanthus*, opened longitudinally, and expanded; twice the natural size.

Richard Roesig del.

R.A.Funke, Leipzig, Lithogr.

PLATE IV.

PLATE IV.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
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mt Transverse muscles.
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n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
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r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

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A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Sicyonis crassa.

Fig. 1. Transverse section through the upper end of the wall and the circular muscle situated there. Ten times the natural size, but drawn with unscr. A, Oc. 2. On the right hand side of the figure for *ek* read *en*.

Fig. 2. A sector of the pedal disk; natural size.

Fig. 3. Longitudinal section through the wall of a wart-like tentacle. Unscr. A, Oc. 2.

Fig. 4. The entire animal, seen from the oral side; natural size.

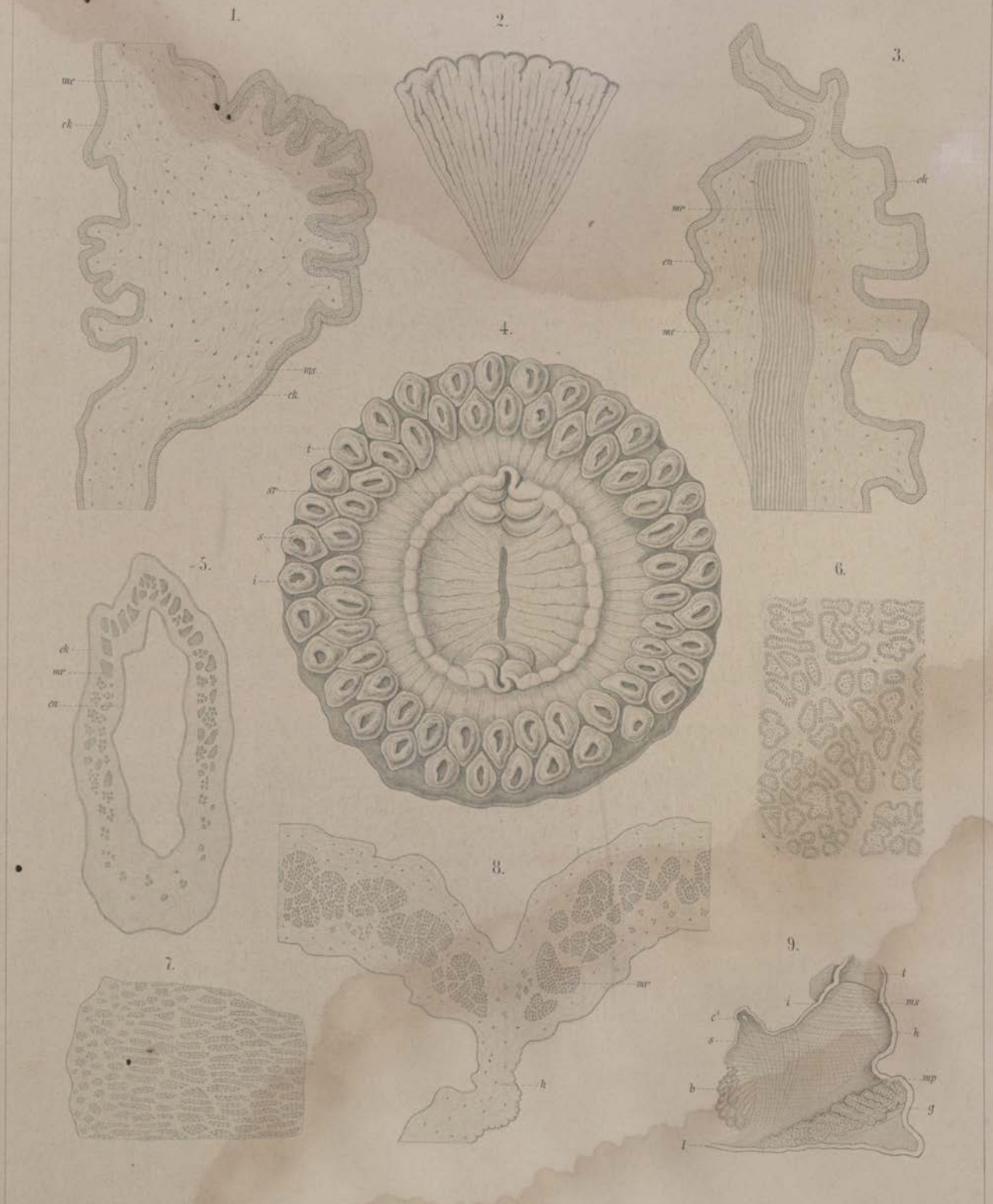
Fig. 5. Transverse section through the basal portion of a tentacle; about six times the natural size.

Fig. 6. Part of a transverse section through the radial muscles of the oral disk. D, Oc. 2.

Fig. 7. Part of a transverse section through the circular muscle; enlarged more than the preceding. D, Oc. 2.

Fig. 8. Transverse section through the oral disk, and insertion of a septum. Unscr. A, Oc. 2.

Fig. 9. Septum; natural size.



Richard Hertwig del.

E. A. Funke, Leipzig, Lithogr.

PLATE V.

PLATE V.

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a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
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h Septa. *rh* Directive septa.
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A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Polystomidium patens.

Fig. 1. The portion of the œsophagus, contiguous to the labial margin, with the openings leading into the radial chambers; three times the natural size.

Fig. 2. Septum with pedal disk, wall, oral disk, œsophagus, and mesenteric filament; natural size.

Fig. 3. Half of the animal seen from the aboral side; natural size.

Fig. 4. Transverse section through the oral disk, near the oral margin. C, Oc. 2.

Fig. 5. Transverse section through a mesenteric filament in the upper part of its course. C, Oc. 1.

Fig. 6. The entire animal, seen from the oral side; natural size. As the only specimen sent for examination was greatly injured, some restoration has been necessary.

Fig. 7. Transverse section through the oral disk, near the stomidia. C, Oc. 2.

Fig. 8. Longitudinal section through the upper end of the wall, the circular muscle running in it and a marginal spherule. Unscr. A, Oc. 2.

Fig. 9. Longitudinal section through the circular muscle. D, Oc. 2.

Fig. 10. Longitudinal section through the lower end of the wall. A, Oc. 2.

Fig. 11. Horizontal section through the circular muscle. A, Oc. 2.

Fig. 12. Transverse section through a septum. Unscr. A, Oc. 2.

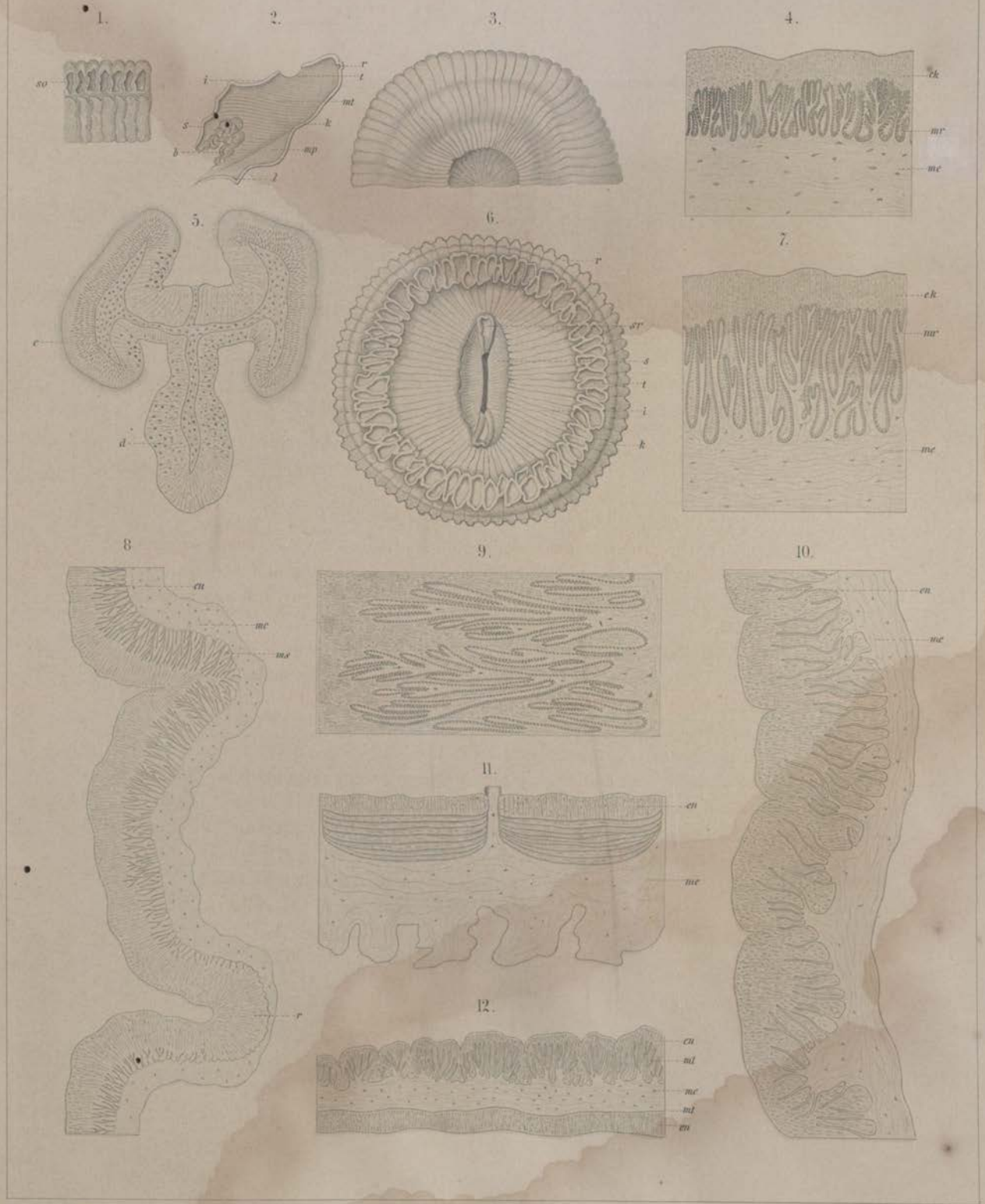

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PLATE VI.

PLATE VI.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Transverse sections through different forms of the circular muscle.

Fig. 1. Circular muscle of *Cereus spinosus.* a^1, Oc. 1.
Fig. 2. ,, ,, *Tealidium cingulatum.* C, Oc. 2.
Fig. 3. ,, ,, *Polysiphonia tuberosa.* a^1, Oc. 2.
Fig. 4. ,, ,, *Tealia bunodiformis.* C, Oc. 2.
Fig. 5. ,, ,, *Phellia pectinata.* a^1, Oc. 2.
Fig. 6. ,, ,, *Comactis flagellifera.* C, Oc. 2.

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PLATE VII.

PLATE VII.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c[1] Perioral stomata.
c[2] Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml[1] Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p[1] Process of the ovicell.
p[2] Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t[1] Principal tentacles.
t[2] Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a[1]	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Leiotealia nymphæa (figs. 1–5).

Fig. 1. Transverse section through the oral disk. A, Oc. 2.

Fig. 2. Radial section through the anterior end of the body, the wall with upper and lower (*ms'*) circular muscles, and the oral disk with a tentacle. Unscr. A, Oc. 2. For *l* in the lettering of the plate read *t*.

Fig. 3. Transverse section through the septum at about one-third the height of the animal, passing perpendicularly through the parietobasilar muscle and longitudinal muscle. A, Oc. 1.

Fig. 4. Half a transverse section of the upper circular muscle. C, Oc. 1.

Fig. 5. Septum; natural size.

Dysactis crassicornis (figs. 6–12).

Fig. 6. Transverse section through a septum. A, Oc. 1.

Fig. 7. Transverse section through the upper end of the wall. Unscr. A, Oc. 2 diminished two-thirds.

Fig. 8. Part of a transverse section through the circular muscle, more highly magnified. D, Oc. 1.

Fig. 9. Section through the circular muscle parallel to the course of the fibrillæ. A, Oc. 2.

Fig. 10. Transverse section through the oral disk of an old animal. Unscr. A, Oc. 2.

Fig. 11. Transverse section through the oral disk of a young animal. Unscr. A, Oc. 2.

Fig. 12. Septum; natural size. The circular muscle appears rather too large in the drawing.

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PLATE VIII.

PLATE VIII.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	550

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Fig. 1. Transverse section through the wall of *Phellia pectinata*. D, Oc. 2.

Fig. 2. Transverse section through the directive septa of *Phellia pectinata* below the œsophagus. A, Oc. 2.

Fig. 3. Part of a transverse section through the longitudinal muscular swelling (retractor) of a septum of *Tealia bunodiformis*.. C, Oc. 2.

Fig. 4. Longitudinal section through the wall of *Tealia bunodiformis* with endodermal saccules. A, Oc. 2.

Fig. 5. Part of a transverse section through the œsophagus, the wall, the directive septa, and the adjoining septa of *Tealia bunodiformis*. a^1, Oc. 1.

Fig. 6. Transverse section through the wall of *Cereus spinosus*. Fig. *a*, a portion of the cuticule, drawn out like a tube. D, Oc. 2.

Figs. 7, 8. Portions of the circular muscle of *Tealidium cingulatum*, taken at different points. J, Oc. 2.

Fig. 9. Endodermal muscles of the oral disk of *Comactis flagellifera*. D, Oc. 2.

Fig. 10. Portion of a transverse section through the circular muscle of *Phellia pectinata*. D, Oc. 1.

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PLATE IX.

PLATE IX.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sx Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Polysiphonia tuberosa (figs. 1–10).

Fig. 1. Transverse section through the pedal disk, showing the muscular fibres which pass on to the furrows. A, Oc. 2.

Fig. 2. Transverse section through a tentacle bulb. a^1, Oc. 1.

Fig. 3. Horizontal section through the pedal disk. The upper part of the diagram is near the outer surface; the lower shows the section passing transversely through the bases of two septa. A, Oc. 2.

Fig. 4. Radial section through the pedal disk. C, Oc. 2.

Fig. 5. Pedal disk, natural size, seen from the lower side; about one-sixth of it shown.

Fig. 6. Transverse section through the tentacle near the point. a^1, Oc. 1.

Fig. 7. Part of a transverse section through the pedal disk (fig. 1) more highly magnified. C, Oc. 2.

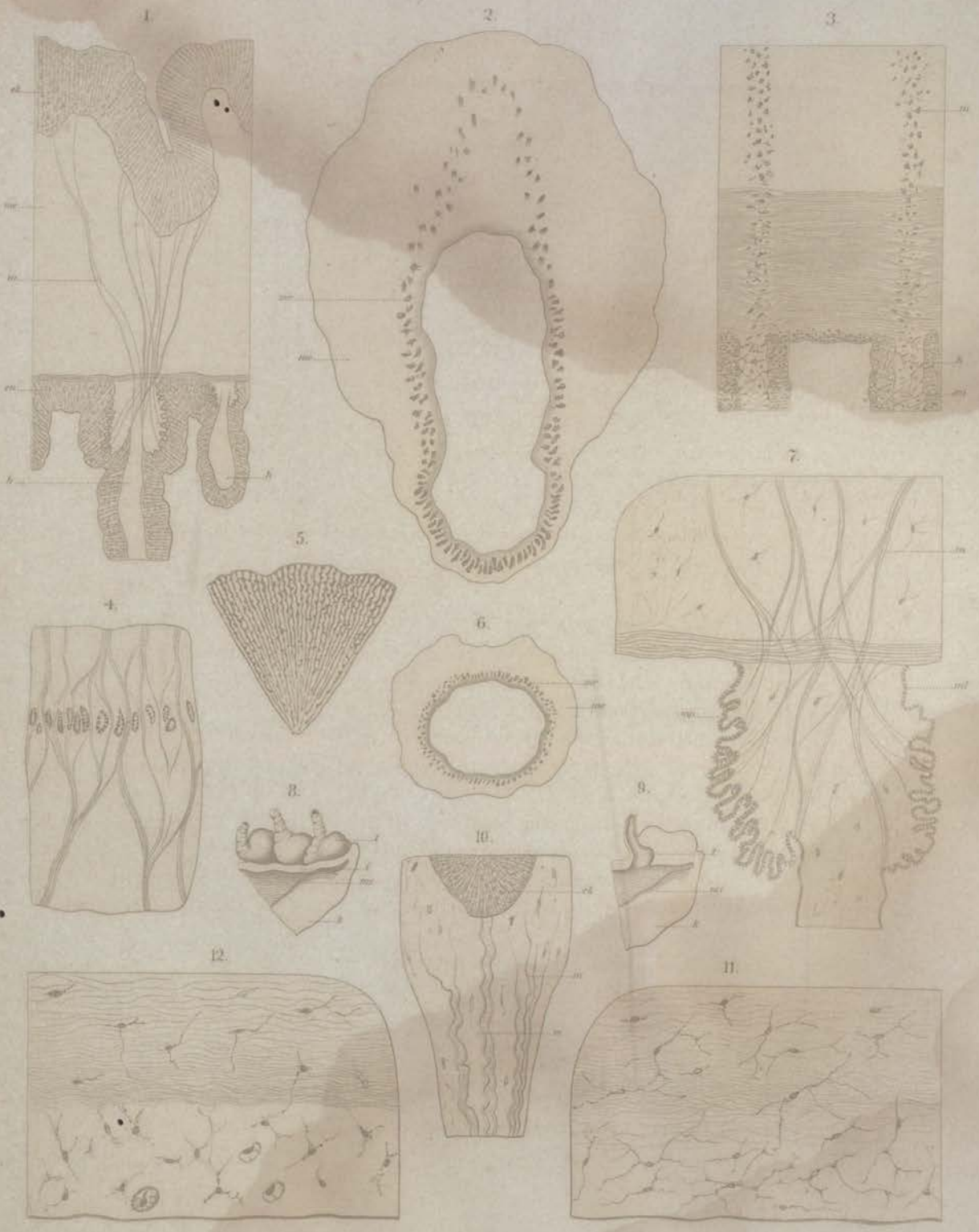
Fig. 8. Tentacles seen from the side; natural size.

Fig. 9. A tentacle divided longitudinally; natural size.

Fig. 10. Bottom of a radial furrow of the pedal disk, with the adjacent muscular fibres; seen in transverse section. C, Oc. 1.

Corallimorphus rigidus (figs. 11 and 12).

Figs. 11 and 12. Transverse sections through the wall.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4.
5.
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7.
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10.
11.
12.

PLATE X.

PLATE X.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

—

Ophiodiscus annulatus (figs. 1–10).

Fig. 1. A portion of the animal, seen from the side; magnified a little.

Fig. 2. Transverse section through a tentacle near the base. Unscr. A, Oc. 2.

Fig. 3. A portion of the animal seen from the oral side; natural size.

Fig. 4. A principal septum with the two adjoining genital septa; magnified a little.

Fig. 5. Transverse section through the oral disk at the insertion of a septum. A, Oc. 2.

Fig. 6. Transverse sections through different parts of the circular muscle: α through the upper part, δ through the lower end. Unscr. A, Oc. 2,

Fig. 7. Portions of the circular muscle, more highly magnified; α from the upper, β from the lower end. D, Oc. 2.

Fig. 8. Pseudo-tentacle, slightly magnified.

Fig. 9. Some terminal branches of the pseudo-tentacle, ten times the natural size.

Fig. 10. Longitudinal section through a branch of the pseudo-tentacle. J, Oc. 1; and reduced one half.

Antholoba reticulata (figs. 11 and 12).

Fig. 11. Transverse section through the circular muscle. D, Oc. 2.

Fig. 12. Transverse section through the oral disk. C, Oc. 1.

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PLATE XI.

PLATE XI.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Polyopis striata (figs. 1–12).

(Figs. 1–8, Unscr. A, Oc. 1.)

Fig. 1. Transverse section through the oral disk near the stomidia, corresponding to line α in fig. 6.

Fig. 2. Transverse section through the oral disk, rather more towards the centre, corresponding to line β.

Fig. 3. Transverse section through the oral disk, still more towards the centre, corresponding to line γ.

Fig. 4. Transverse section through the upper part of the œsophagus and the openings lying in it.

Fig. 5. Transverse section through the oral disk, near the oral opening, corresponding to line ϵ.

Fig. 6. Surface view of a part of the oral disk. Unscr. A, Oc. 1, and reduced to one-eighth.

Fig. 7. Transverse section through the oral disk, nearly midway between figs. 3 and 5, corresponding to line δ.

Fig. 8. Transverse section through the lower part of two directive septa.

Fig. 9. Transverse section through a septum and the oral disk in the region of the stomidia. A, Oc. 2.

Fig. 10. Radial section through the oral disk, endodermal side. C, Oc. 2.

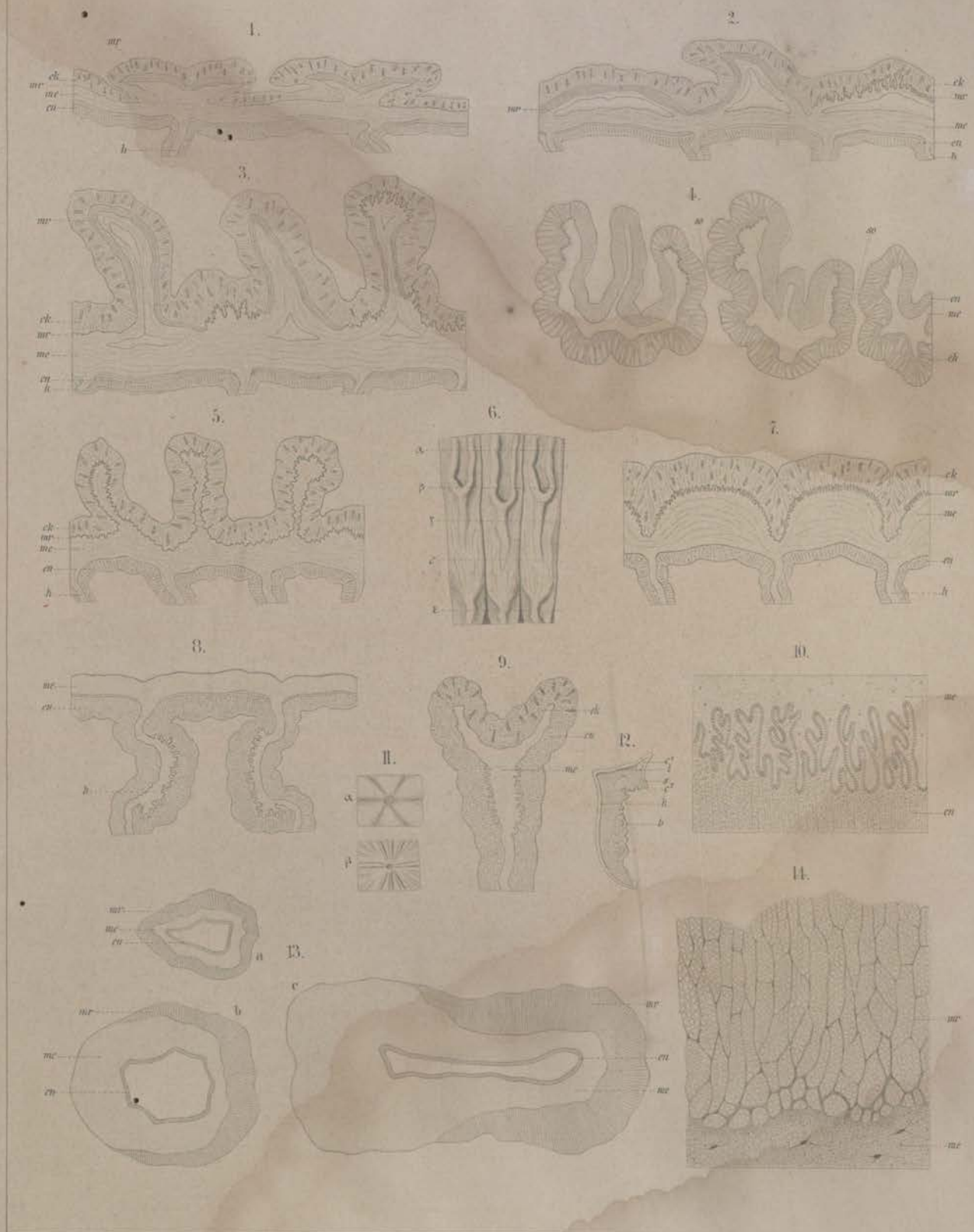
Fig. 11. The lower end of the body-wall α seen from the ectodermal side, β seen from the gastric side, about twice the natural size.

Fig. 12. Septum with adjacent portion of the wall, oral disk and œsophagus; natural size.

Paractis excavata (figs. 13 and 14).

Fig. 13. Transverse sections through a tentacle, *a* at the point, *b* in the middle, *c* at the base. Unscr. A, Oc. 1.

Fig. 14. Part of a similar transverse section more highly magnified. D, Oc. 1.



Richard Hertwig del. F. A. Funke, Leipzig, Lithogr.

PLATE XII.

PLATE XII.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments
c Stomata in the septa.
c[1] Perioral stomata.
c[2] Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml[1] Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
mz Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p[1] Process of the ovicell.
p[2] Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t[1] Principal tentacles.
t[2] Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a[1]	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	580

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Corallimorphus rigidus. D, Oc. 2 (figs. 1–7).

Figs. 1–4. Young ovicells in the endoderm; in figs. 2 and 3 two cells depicted in the act of migrating into the mesoderm.

Fig. 5. Ovicells with filamental apparatus; the epithelial cells of the filamental apparatus still lie completely in the epithelium.

Fig. 6. Ovicells with filamental apparatus; the epithelial cells of the filamental apparatus migrating into the mesoderm.

Fig. 7. Ovicells with filamental apparatus.

Halcampa clavus. D, Oc. 1 (figs. 8, 9, 11).

Figs. 8 and 9. Two ovicells of different ages with the epithelial apparatus.

Fig. 11. Ovicells which lie partly in the endoderm, partly in the mesoderm.

Cereus spinosus (fig. 10).

Fig. 10. Transverse section through an acontium of *Cereus spinosus.* C, Oc. 2.

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me
3.
en
o
me
4.
en
o
o
me
5.
en
p²
p¹
o
6.
en
p²
me
o
7.
en
p
me
o
8.
d
d
p²
en
p¹
o
me
9.
en
p²
me
p¹
o
10.
n
en
me
11.
en
me
d
o
d
en
o
me

PLATE XIII.

PLATE XIII.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Fig. 1. Transverse section through the mesoderm, ectodermal epithelium, and cuticle of *Scytophorus striatus*. D, Oc. 2.

Fig. 2. Longitudinal section through the pleated circular muscles of the wall at the lower end of *Halcampa clavus*. A, Oc. 1.

Fig. 3. Transverse section through the body of *Scytophorus striatus* passing through the œsophagus. a^1, Oc. 1.

Fig. 4. Transverse section through the body of *Halcampa clavus*, passing through the œsophagus. a^1, Oc. 1.

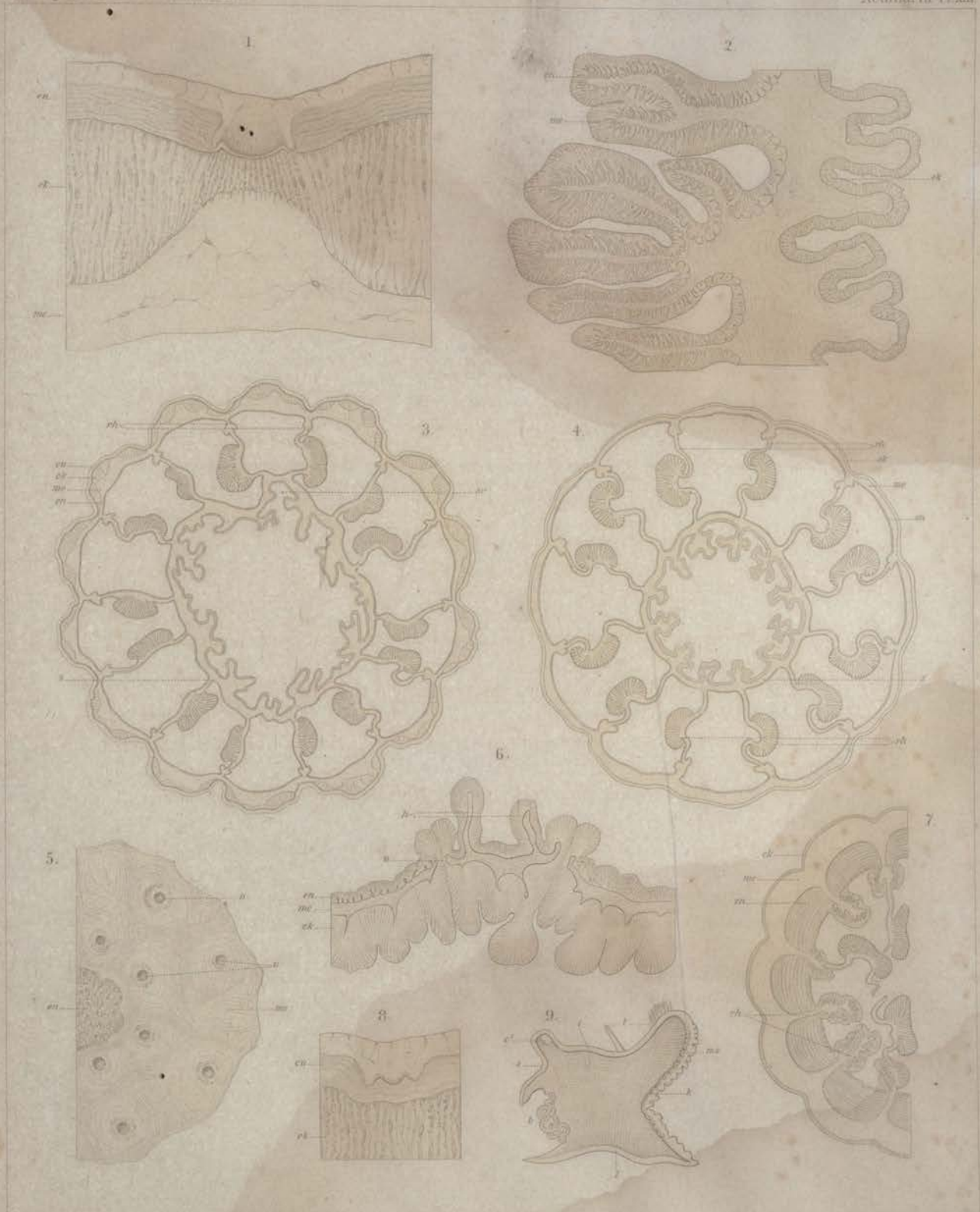
Fig. 5. Section parallel to the surface through the pedal disk of *Halcampa clavus*. C, Oc. 1.

Fig. 6. Transverse section through the pedal disk of *Halcampa clavus*. C, Oc. 1.

Fig. 7. Half a transverse section through the lower extremity of *Halcampa clavus*. a^1, Oc. 1.

Fig. 8. Transverse section through the cuticle of *Scytophorus striatus*. D, Oc. 2.

Fig. 9. Septum of the first order of *Anthobolia reticulata*; natural size.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9.

PLATE XIV.

PLATE XIV.

The lettering is the same in all the figures.

a Acontia.
b Mesenteric filaments.
c Stomata in the septa.
c^1 Perioral stomata.
c^2 Marginal stomata.
cu Cuticle.
d Glandular streaks of the mesenteric filaments.
e Ciliated streaks of the mesenteric filaments.
ek Ectoderm.
en Endoderm.
g Reproductive organs.
h Septa. *rh* Directive septa.
i Oral disk.
k Wall.
l Pedal disk.
m Muscles.
mm Mesodermal muscles.
ml Longitudinal muscles of the septa.
ml^1 Retractor.
mp Parietobasilar muscle.
mt Transverse muscles.
mr Radial muscles of the oral disk and longitudinal muscles of the tentacles
ms Circular muscle of the wall.
me Mesoderm.
n Urticating cells.
o Ovicells.
p Filamental apparatus of the ovicells.
p^1 Process of the ovicell.
p^2 Apical set of epithelial cells.
r Marginal spherules.
rh Directive septa.
s Œsophagus.
so Openings of the œsophagus into the radial chambers.
sr Œsophageal grooves.
sz Lappets of the œsophagus.
t Tentacles and the openings homologous with them.
t^1 Principal tentacles.
t^2 Accessory tentacles.
v Openings of the pedal disk.

All statements given as to magnifying powers have reference to Zeiss's system. The magnifying powers amount to

	Oc. 1.	Oc. 2.		Oc. 1.	Oc. 2.
a^1	6	10	D	195	240
A	55	70	F	410	550
C	95	125	J	470	530

A with unscrewed front lens (unscr. A) magnifies with Oc. 1 : 30 times; with Oc. 2 : 40 times.

Zoanthus, sp. ? (figs. 1–4 and 6).

Fig. 1. Longitudinal section through the upper end of the wall and the circular muscle running in it. Unscr. A, Oc. 2.

Fig. 2. Transverse section through the wall, œsophagus, macrosepta and microsepta. A, Oc. 2.

Fig. 3. Transverse section through an individual of a *Zoanthus* colony. The figure is composite, the left-hand half representing a transverse section on a level with the œsophagus, the right-hand half a transverse section situated rather further down. a^1, Oc. 2.

Fig. 4. Part of a transverse section through the wall. D, Oc. 2.

Fig. 6. Transverse section through a small individual of a *Zoanthus* colony, passing through the œsophagus. a^1, Oc. 2.

Epizoanthus parasiticus (fig. 5).

Fig. 5. Part of a transverse section through the wall of *Epizoanthus parasiticus*. D, Oc. 2.

Liponema multiporum (fig. 7).

Fig. 7. Marginal portion of the oral disk of *Liponema multiporum*; twice the natural size.

Sphenopus arenaceus (fig. 8).

Fig. 8. Transverse section through the wall of *Sphenopus arenaceus*. D, Oc. 2.

R. Hartwig del.

Lith. Anst. v. Werner & Winter, Frankfurt a/M.

THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the TUNICATA collected during the Voyage of H.M.S. Challenger during the years 1873–76. By WILLIAM A. HERDMAN, D.Sc., F.L.S., F.R.S.E., Professor of Natural History in University College, Liverpool.

PART I.—ASCIDIÆ SIMPLICES.

PREFACE.

THIS collection of TUNICATA, entrusted to me for description by the late Sir C. Wyville Thomson,[1] was placed in my hands early in May 1879. As most of the specimens were in muslin bags packed in large bottles, it was difficult to form a correct idea of the size of the collection. When unpacked and arranged roughly in species it proved to be much larger than had been at first estimated. Since then I have several times received from Mr. Murray bottles of Tunicata which had been accidentally included in other collections, and specimens which had been overlooked in sorting out the different groups. The pelagic forms taken in the tow-net (including the Pyrosomidæ, the Appendiculariidæ, and the Thaliacea) did not reach me till some time afterwards.

My first object was to separate the collection of fixed Tunicata into Simple, Social, and Compound Ascidians. I then commenced to work through the first two of these groups in

[1] I wish here to record my deep sense of indebtedness to Sir Wyville Thomson, for having given such an important piece of work into my charge, and for the ever ready and valuable advice with which he aided me during the first part of my investigations.

detail; and as the descriptions and plates of this part of the collection are now finished, and it may be some months before those of the Ascidiæ Compositæ and the Pelagic Tunicates are completed, it is thought best to publish the Report upon the Ascidiæ Simplices separately. The Bibliography, however, and some other parts of the Introduction, refer to the whole group of the Tunicata.

The collection generally was in an excellent state of preservation; but some few specimens, with exceptionally solid tests, had suffered apparently from the apertures having contracted so completely as almost to exclude the alcohol. The precaution of making an incision in the test had been taken in the case of most of the large specimens. Specimens of a few of the Compound Ascidians and Pelagic forms had also been preserved in absolute alcohol.

The collection of Ascidiæ Simplices consists of eighty-two species arranged in twenty genera. Seventy-four of the species and nine of the genera were new to science.[1] These species added by the Challenger Expedition have not necessitated the formation of a single new family. Although a number of new genera have been required, usually for the forms from great depths, yet these have all found a place in one or other of the four families already known. The new genera have in several cases been of great interest, as they have demonstrated affinities between known forms, and have exhibited combinations of characters necessitating in some cases a revision of the definitions of old genera, and even affecting in one or two instances our ideas with regard to the characters of the families.

In 1876 Professor Moseley described, in the Transactions of the Linnean Society, two very remarkable Ascidians which he had investigated during the voyage of the Challenger. The first of these, *Hypobythius calycodes*, belongs to the family Ascidiidæ; the second, *Octacnemus bythius*, seems to me to be nearer to the Thaliacea than to the Ascidiacea, and consequently comes into the second part of this Report.

The new species are all illustrated and described in detail. Species previously known are not figured, except in cases where they have been imperfectly described, or where the Challenger specimens show some special feature.

[1] Most of these new species were named and briefly described in my four Preliminary Reports upon the collection read before the Royal Society of Edinburgh (see Proc. Roy. Soc. Edin., Sessions 1880–82).

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INTRODUCTION.

There is no large work on the Tunicata as a class, nothing of the nature of a revision of the group, to which one may refer for the results of the numerous memoirs and widely scattered papers which have been written on particular forms and special points in anatomy. It seems therefore almost necessary to give, as an introduction to the description of so many new genera and species of Ascidians, an outline of the history of the group, a full bibliography, and a short account of the anatomy and histology of the principal forms.

HISTORY.[1]

The history of the literature of this, as of almost every other group of animals, extends back to about 330 B.C., when Aristotle in his History of Animals gave, under the name of *Tethyum*, a short account of a Simple Ascidian. He described briefly the external appearance and the nature of the test, referred to the apertures and their inhalent and exhalent functions, mentioned the mantle as a sinewy membrane lining the shell-like substance, and evidently recognised the branchial and atrial chambers and the alimentary canal—all the more important points in the macroscopic anatomy of the animal.

The only other writers of classical times who mention Ascidians are Pliny and Ælian, and they seem to have made little or no advance upon the knowledge of Aristotle.

After this the record of Ascidiology takes a great leap over nearly fourteen centuries —the dark ages of literature and science—and brings us to the middle of the sixteenth century, when Bellonius and Rondeletius wrote treatises upon marine animals, some of which we can recognise either from the figures or descriptions as Ascidians.

During the next hundred years Aldrovandus, Avicenna, Gesner, Jonston, Redi, and Sloane, wrote on Marine Zoology, and contributed more or less to the knowledge of the Tunicata.

Schlosser first brought the Compound Ascidians into notice by his paper in the Philosophical Transactions for 1756, containing a description of *Botryllus*, with some observations by John Ellis. A few years later, A. Russel described and figured an undoubted *Boltenia* from the coast of North America. Baster, shortly afterwards, in his Opuscula Subseciva, described a species of Tunicate to which he gave the name *Ascidium*, and compared its organisation with that of the oyster. Pallas suggested the union

[1] As a rule, only works of considerable importance are referred to in this outline of the history. The complete titles and dates of these and other works on the Tunicata will be found under the authors' names in the Bibliography.

of *Tethyum* and *Ascidium* under one name, and this was afterwards effected by Linnæus (Sys. Nat., 12th ed.), who designated the genus *Ascidia.*

Bolten's papers on the remarkable form which bears his name were published in 1770 and 1771, and the observations of Gaertner, Forskål, Phipps, Pallas, Dicquemare, Fabricius, and others, all of whom described and usually figured new species of Simple Ascidians, appeared during the next ten years. The most important contribution of this period (the end of the eighteenth century) was the work of O. F. Müller. His Prodromus was issued in 1776, and contained a considerable list of named species of Tunicates, while his great work, the Zoologia Danica, gave most valuable descriptions and figures of twenty species.

Bruguiere, in the Encyclopédie Méthodique, collected all that had been done previously, but added little that was new or important. His work, therefore, represents the state of knowledge of the group up to the year 1800.

In the commencement of the present century valuable anatomical researches were made by Schalk, Carus, and especially Cuvier, who arranged the Ascidians along with the Mollusca under the name of Acephala nuda. At this period also, the genus *Pyrosoma* was described first by Péron, and afterwards by Péron and Lesueur; and the latter in conjunction with Desmarest wrote a memoir upon the structure of *Botryllus.* But by far the most important contributions of this period were the celebrated memoirs of Savigny, published in 1816. This author first satisfactorily elucidated the structure of the Compound Ascidians, and distinguished them from the Alcyonarians with which they had previously been confounded. His accounts of the different genera which he instituted, are models of patient and careful research, and the accuracy of his descriptions and figures is wonderful.

Savigny's memoirs upon the Simple Ascidians are no less remarkable. He broke the group up into four great genera—*Phallusia, Cynthia, Boltenia,* and *Clavelina*—which might almost be taken as types of the four families, Ascidiidæ, Molgulidæ,[1] Cynthiidæ, and Clavelinidæ. Some of these genera he further divided, and these subdivisions are in several cases now recognised as genera; and finally he described and figured a large number of new species. Lamarck, in his Histoire Naturelle, profiting by the anatomical discoveries of Cuvier and Savigny, characterised a number of Ascidians, Simple as well as Compound, and arranged them as a class, the Tunicata, intermediate between the Radiata and the Vermes.

Every year now brought new additions to our knowledge. Chamisso made his well-known observations upon *Salpa* about this time, and first noticed the series of phenomena afterwards more fully described by Steenstrup in 1842 as "alternation of generations;" while a little later we have Kuhl and van Hasselt's investigations upon the heart of the same form, resulting in the discovery of the alternation in the directions in which the wave of contraction passes along the heart, and the blood flows in the vessels.

[1] Taking Savigny's *Cynthia dione* as a *Molgula*, which it probably is.

In 1828 Audouin and Milne-Edwards announced their discovery of the metamorphosis through which the Ascidian passes in its development from the embryo to the adult form. This was also independently discovered in the various groups of Tunicata at later dates by Lister, Sars, Dalyell, van Beneden, Agassiz, Krohn, and Gosse.

The important works of Delle Chiaje, Lesueur, and Macleay also appeared at this time, the latter adding considerably to our knowledge of the Bolteninæ. A considerable number of works of less importance, being chiefly descriptions of new species, appeared in the second quarter of the century, the most notable being those of Lesson, Quoy and Gaimard, Milne-Edwards and Audouin, Risso, and Ehrenberg. Broderip and Sowerby first described the remarkable *Chelyosoma*, and Mertens his *Oikopleura*, one of the Appendiculariidæ, about this time. Shortly afterwards (1834), some excellent observations upon Social and Compound Ascidians were made by J. J. Lister, and appeared in the Philosophical Transactions. This author investigated the common vascular system in a species which was afterwards named *Perophora listeri* by Wiegmann (1835).

The curious *Pelonaia*, a form allied to *Styela*, was discovered and brought before the British Association by Goodsir and Forbes in 1840, and about this time Eschricht's observations upon Salpæ were published in Denmark, to be followed two years later by his detailed account of the anatomy of *Chelyosoma*. This was also the date of Milne-Edwards' "Observations sur les Ascidies Composées des côtes de la Manche," one of the most important memoirs upon this group of the Tunicata.

In this country a number of short papers, chiefly by Goodsir and Forbes, Thompson, Macgillivray, Carpenter, Allman, Peach, and Alder, made their appearance between 1840 and 1845. They contain descriptions of new species, and occasionally discussions upon the systematic position and classification of the Tunicata.

In 1845 Carl Schmidt first announced the presence in the test of some Tunicata of tunicine, a substance very similar to cellulose, and in the following year Löwig and Kölliker confirmed the discovery, and made some additional observations. An important memoir by van Beneden on the embryology, anatomy, and physiology of Simple Ascidians appeared in Belgium in 1847. In the following year the first part of Forbes and Hanley's British Mollusca was published. This gave descriptions of all the known species of British Ascidians, many of them figured, and contained a great deal of original matter. At the same time Rupert Jones' article "Tunicata" in Todd's Cyclopædia made its appearance: an excellent summary of what had been done previously, and of the state of our knowledge of the group at the time. Alder's Catalogue of the Marine Mollusca of Northumberland and Durham, published shortly afterwards, added some new species to our British fauna.

About this time Huxley began his observations upon the pelagic Tunicates, and two important papers by him appeared in 1851 in the Philosophical Transactions, one upon the anatomy of *Salpa* and *Pyrosoma*, and the other upon *Appendicularia* and *Doliolum*. Gegenbaur, Vogt, H. Müller, Krohn, and Leuckart a few years later contributed further

observations, especially upon *Doliolum* and *Appendicularia*. In America, Stimpson described a number of new species, both from the American coasts and from the seas of China and Japan. Dr. J. D. Macdonald now commenced his valuable series of observations upon Tunicata, both pelagic and fixed. He described many new species from different parts of the world, including some most remarkable forms, such as *Chondrostachys*, and *Diplosoma*.

Bronn's "Thierreichs" (1852) contains the most complete revision of the entire group which has yet been published. After a short history and a list of the principal works on the subject, a complete and detailed account of the anatomy and embryology as known at that time is given. This is followed by a tabular classification with diagnoses of the orders, families, and genera; the whole concluding with a section on the distribution of the group.

Grube's observations upon the Fauna of the Island Lussin, containing descriptions of some new or imperfectly known Ascidians, and Lacaze-Duthiers' paper upon *Chevreulius*, previously described as *Rhodosoma* by Ehrenberg in 1828, appeared a few years later.

The following year (1866) was the date of the appearance of one of the most important memoirs in the entire range of embryology, namely, Kowalevsky's "Entwickelungsgeschichte der einfachen Ascidien." This was the first time that the Tunicata had been treated according to modern embryological methods, and that the development of the various organs had been worked out cell by cell, and their origin traced back to particular cell masses. Up to this period all that was known of the process of development of a Simple Ascidian was from Krohn's paper in 1852, on the embryology of *Phallusia mammillata*, in which the various organs were described in the fully developed tailed larva, but their process of development in the embryo was scarcely investigated. Hence Kowalevsky worked upon comparatively fresh ground, and his remarkable memoir contained results of the greatest novelty. He was the first to demonstrate the striking similarity between the relations of the nervous system, the notochord, and the alimentary canal in the larval Ascidian, on the one hand, and the vertebrate embryo on the other. He also traced the development of the chief organs of the tailed larva from the segmented ovum, and showed, in this case also, a certain similarity to the embryonic development in a vertebrate. This pointed clearly to the fact that the Tunicata are closely allied to the Vertebrata, and that the tailed larva represents the primitive or ancestral form from which the adult Ascidian has degenerated; and this led naturally to the view usually accepted at the present day, that the group is a degenerated side branch from the lower end of the vertebrate phylum.

Kowalevsky's paper naturally drew other investigators into the same field. One of the most important of these was Kupffer, who first of all took up the subject with the view of, if possible, disproving Kowalevsky's results, but was speedily converted, and soon became one of the strongest supporters of the new views. He published several

important papers corroborating Kowalevsky's results in all essential points, though differing from him in some minor details. Kowalevsky has since published several other embryological papers, chiefly extending his discoveries to other groups of the Tunicata.

Hancock took up the Ascidians of the British Seas, at first in conjunction with Alder, who had already (1863) worked at the group. They described a number of new species, and Hancock in 1868 published some of his anatomical observations in the Journal of the Linnean Society. At the time of his death he was collecting material for a Monograph upon the British Tunicata.

In 1871–72 Verrill described a number of new species and genera of Ascidians from the coasts of North America.

In the following year Giard published a large work upon the Synascidiæ containing the descriptions of a considerable number of new species, and also many important anatomical observations. About this time O. Hertwig's paper on the structure of the test made its appearance. This was by far the best paper that had yet appeared on this subject, and it satisfactorily determined the structure of the different parts and their relations to one another. The most important points have since been confirmed by Semper in his paper on the presence of cellulose in the Ascidian test, published in 1875. A paper by R. Hertwig, the brother of the above-named author, which also appeared in 1872, contains a number of valuable anatomical observations, especially upon the structure of the endostyle; while, during the few years that had elapsed since Kowalevsky's and Kupffer's first researches, many further details as to the embryology of Simple Ascidians, and the process of gemmation in the Compound forms, had been obtained by the investigations of Krohn, Metschnikoff, Kowalevsky, Stepanhoff, Kupffer, and others.

At this time also (1872) an important memoir by H. Fol, upon the Appendiculariidæ of the Straits of Messina made its appearance.

In 1874 Ussow's memoir upon the histology of the nerve ganglion and the neighbouring organs was published in Russia. In this it is shown that the gland lying below the ganglion has a duct which runs forwards to terminate in the so-called "olfactory tubercle."

In this same year Lacaze-Duthiers commenced the publication of his important work upon the Ascidiæ Simplices of the coast of France. His first part was anatomical. A species of *Molgula* was chosen as a type, and all its organs were described with great thoroughness and minuteness. Lacaze-Duthiers, however, throughout regards the Ascidian as a modified Lamellibranch mollusc. His second part, published a few years later (1877), contains a systematic description of the family Molgulidæ. He introduces two new genera, *Anurella* and *Ctenicella*, of which the former differs from *Molgula* chiefly in the fact that its embryos never develope into tailed larvæ, but undergo a modified process of development. The species are all described with great minuteness, and are

beautifully illustrated. Heller's "Untersuchungen" commenced in 1874, and the last part published (Abth. iii. 1) appeared in 1877. The work is devoted to a description of the Simple Ascidians of the Adriatic and Mediterranean seas, and commences with an account of the anatomy of *Ascidia mentula*. In the succeeding systematic part a number of new species are described, most of them briefly, a few with a considerable amount of mical detail. Kupffer's report upon the Tunicata collected by the German North Sea Expedition contains descriptions of several new Simple Ascidians, and anatomical notes upon some imperfectly known species.

An important paper by Fol, which appeared in 1874, must not be overlooked. It gives an account of the structure and function of the endostyle, showing its glandular and non-nervous nature.

In 1875 Kowalevsky's elaborate memoir upon the development of *Pyrosoma* was published. Huxley had long before (1862) investigated this genus, and described the remarkable "Cyathozooid" which gives rise to the first "Ascidiozooids" of the colony. Kowalevsky's researches confirmed Huxley's discovery, and gave fuller details of some of the stages.

In the same year Todaro's and Brooks' elaborate but in some points rather conflicting accounts of the development of *Salpa* made their appearance.

In 1880 a paper appeared upon the Simple Ascidians of the seas of Denmark by Traustedt, containing descriptions of a number of old and imperfectly described, and a few new, species. It also settled some questions of priority in naming, and gave very full lists of the synonyms of the species. A second paper by the same author has just appeared (1882), containing descriptions of some new West Indian species of Ascidiidæ.

In 1881 a very important memoir by C. Julin was published in the Archives de Biologie. This paper gives the results of anatomical investigations into the condition of the nervous system and some neighbouring organs in a few species of the Ascidiidæ. Julin corroborates Ussow's account of the relations of the subneural gland to the olfactory or dorsal tubercle, and further declares that the latter organ is nothing more than the complicated aperture of the duct from the gland, and that it has nothing whatever to do with an olfactory or any other sensory function. Julin considers that the gland is homologous with the pituitary gland of vertebrates, and that the duct and aperture into the branchial sac represent the embryonic connection of the pituitary gland with the pharynx. In a second paper published in 1882 Julin extends his observations to two other species of *Ascidia*, and enunciates a theory suggested by Professor E. van Beneden that the subneural gland in the Ascidian, and the pituitary gland in the vertebrate embryo have a renal function, and may be considered as kidneys specially developed for the elimination of effete matters from the blood circulating in the neighbourhood of the central nervous system.

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ANATOMY.

This section is intended merely as a short account of what is known of the anatomy of the group, without entering into much histological detail. It is considered useful to insert this upon two accounts, firstly, as a means of giving and explaining a complete system of the nomenclature of parts in the group, a matter which has always been involved in considerable confusion; and secondly, as a basis from which to start in the consideration of the structure of the new genera and species, so that their peculiarities may be more readily noticed and appreciated.

The minute anatomy of certain special forms (*e.g.*, *Culeolus murrayi*, see page 91) will be found in their proper places in the systematic part of the memoir.

Classification.

The following is the scheme of classification of the Tunicata which I have adopted :—

Class—TUNICATA.

Order I. ASCIDIACEA.

Sub-order I. *Ascidiæ Simplices.*

Family 1. Molgulidæ.
„ 2. Cynthiidæ.
„ 3. Ascidiidæ.
„ 4. Clavelinidæ.

Sub-order II. *Ascidiæ Compositæ.*

Family 1. Botryllidæ.
„ 2. Didemnidæ.
„ 3. Distomidæ.
„ 4. Polyclinidæ.
„ 5. Diplosomidæ.

Sub-order III. *Ascidiæ Salpiformes.*

Family Pyrosomidæ.

Order II. THALIACEA.

Family 1. Doliolidæ.
„ 2. Salpidæ.

Order III. LARVACEA.

Family Appendiculariidæ.

The Position.

Before describing any part of the anatomy of an Ascidian, it is necessary to state the position in which one considers its body placed, and to define such terms as anterior, posterior, dorsal, and ventral; as these have been used by some writers to denote entirely different regions of the body.

Savigny[1] placed his specimens, when describing them, in the natural position in which most species are found, namely, with the apertures (or the branchial aperture when they are far apart) superior, and the base of attachment inferior. He called the edge on which the atrial aperture is placed the anterior region, and the opposite side, that next the endostyle, posterior. Consequently, in all typical Simple Ascidians (*e.g.*, *Ascidia mentula*), according to Savigny's nomenclature of regions, the stomach and intestine would lie on the right side of the branchial sac.

Alder (1863),[2] Alder and Hancock (1870), and afterwards Hancock alone (1870),[3] employed a modification of Savigny's method. Their right and left sides were the same as Savigny's, but they designated the region of the branchial aperture anterior, and the base of attachment posterior. The two edges (anterior and posterior of Savigny) they called dorsal and ventral. This was a distinct improvement, but the two last terms were misapplied, the atrial edge being considered ventral, and the endostyle dorsal.

Milne-Edwards,[4] like Savigny, placed the body upright, and called the branchial end superior, and the place of attachment inferior. He differed from Savigny, however, in considering the endostyle as anterior, and the atrial region as posterior, the result being that his right and left sides are not synonymous with those of Savigny.

Kupffer's[5] terms are partly those of Milne-Edwards. He calls the region of the branchial aperture either superior or anterior, and the base of attachment inferior or posterior. The edges, however, he designates as dorsal and ventral, applying these terms not as Alder and Hancock did, but correctly—the atrium being dorsal, and the endostyle ventral. The right and left sides thus come to be the same as those of Milne-Edwards. Heller's[6] system is much the same; he places the animal upright, and calls the branchial aperture anterior, and the endostyle ventral. R. Hertwig[7] also considers the branchial aperture as anterior or oral, and the base of attachment as posterior or aboral, while the dorsal side is indicated by the nerve ganglion, and the ventral by the endostyle.

Lacaze-Duthiers[8] adopts an extraordinary system of nomenclature. He places the

[1] Mém. sur les anim. sans Vert., part ii. fasc. 1.
[2] Observ. on Brit. Tun., *Ann. Mag. Nat. Hist.*, ser. iii., vol. xi. p. 152.
[3] On the larval state of *Molgula*, &c., *Ann. Mag. Nat. Hist.*, ser. iv., vol. vi. p. 353.
[4] Observ. sur les Asc. Comp., &c., *Mém. de l'Acad. de Paris*, vol. xviii. p. 217.
[5] Jahresberichte der Kommission zur Untersuchung der deutschen Meer in Kiel. Berlin, 1874.
[6] Untersuch. ü. d. Tun. des adriat. Meeres, *Denkschr. k. Akad. Wissensch.*, Bd. xxxiv.
[7] Beiträge zur Kenntniss des Baues der Ascidien, *Jen. Zeitschr.*, vol. viii. p. 74.
[8] Asc. Simp. des côtes de France, *Arch Zool. expér.* t. iii.

animal in the reverse position to that employed by most authors, that is, he has the base of attachment upwards, and the branchial aperture hanging down. These are his superior and inferior regions; then the endostyle is placed forwards and called anterior, while the opposite edge—the atrial part—is posterior. The result is that the stomach lies on what Lacaze-Duthiers considers the right side of the branchial sac—the same arrangement as was obtained by the systems of Savigny and Hancock, although the last mentioned authors placed the animal so that the branchial aperture should be superior (see diagrams in Lacaze-Duthiers' memoir).

Julin,[1] and apparently Traustedt[2] also, employ the same nomenclature as Heller, and this is the system adopted in the present work. If the animal be placed with the endostyle downwards, and the branchial aperture pointing away from the observer, then the two sides correspond with his right and left hands. The region of the branchial aperture (fig. 1, *Br.*)

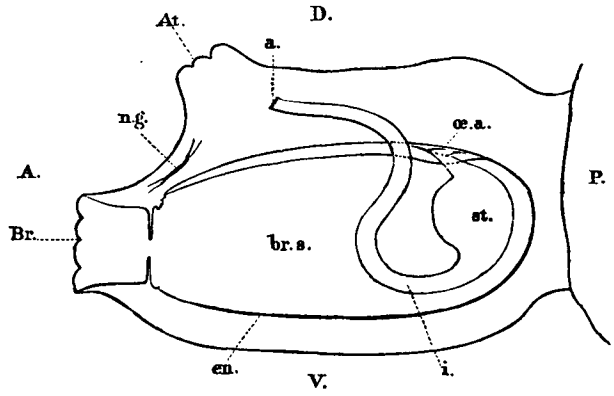


FIG. 1.—Diagram showing the position of an Ascidian, viewed from the left side.

A., anterior end; *P.*, posterior end; *D.*, dorsal edge; *V.*, ventral edge; *Br.*, branchial aperture; *At.*, atrial aperture; *br.s.*, branchial sac; *en.*, endostyle; *œ.a.*, œsophageal aperture; *st.*, stomach; *i.*, intestine; *a.*, anus; *n.g.*, nerve ganglion.

is thus anterior, and the opposite end, usually the place of attachment, is posterior; the lower surface, along which the endostyle (*en.*) runs, is ventral, and the opposite edge, on some part of which the atrial aperture generally opens, is dorsal.

According to this system, the stomach (*st.*) and intestine lie (in most of the genera and species of Simple Ascidians, *e.g.*, *Ascidia mentula*) upon the left side of the branchial sac (fig. 1) and this side corresponds to the *left* side of Milne-Edwards, Kupffer, Heller, Hertwig, Traustedt, and Julin, but to the *right* side of Savigny, Alder, Hancock, Lacaze-Duthiers, &c.

[1] Recherches sur l'Organisation des Ascidies Simples, *Arch. de Biologie*, vol. ii. p. 59.

[2] Oversigt over de fra Danmark, &c., Asc. Simp., *Vid. Medd. Nat. For. Kjøbenhavn*, 1879-80.

The Test (Testa, Tunica Externa, Cellulose Mantle, Outer Mantle, Cartilaginous Sac).

The test or outer tunic (sometimes incorrectly called the mantle), from which the class derives its name, is one of the most characteristic features of the group. It undergoes many and various modifications, but it is present, and is recognisable as a "test," or "investing mass," in almost every member of the class. It possesses the additional interest of being the organ in which Karl Schmidt, in 1845, made his well-known discovery of cellulose in the animal kingdom. Since that date the principal works on the structure of the test in the Tunicata have been those of Löwig and Kölliker (1846), Schacht (1851), F. E. Schulze (1863), Oscar Hertwig (1872), and Semper (1875).

In a Simple Ascidian the test is a more or less thickened coat forming the outer layer of the body wall. It varies greatly in shape according to the species, and even to a considerable extent according to the individual, being greatly affected by surrounding circumstances. In the so-called Social Ascidians (the family Clavelinidæ) it forms in addition the stolons or creeping roots, which connect the different individuals of the "Society," and contain the connecting blood-vessels. In the Ascidiæ Compositæ it is represented by the "investing mass," the tests of the different Ascidiozooids of the colony having fused together into a common ground mass or matrix. In *Pyrosoma* also there is a colonial mass representing the united tests of the different Ascidiozooids; while in *Salpa* the test forms the outer layer of the body of each individual, as in the Ascidiæ Simplices. In the Appendiculariidæ the test is represented by the structure usually known under the name "Haus," given by its discoverer Mertens. This is only formed at certain times, so that in these Tunicates there is sometimes no test. In certain species of *Doliolum*, also, there appears to be no test.

The external surface is always more or less irregular and prone to develope knobs, hairs, spines, and other processes. This is especially the case at the posterior end of the fixed forms, where the test frequently pushes out long branched processes to serve as roots for the attachment of the Ascidian to foreign bodies.

In the adult condition it is histologically an abnormal form of connective tissue, consisting of protoplasts of various forms imbedded in a matrix which also varies greatly in its characters. The test is in all cases lined by a layer of epithelial cells, the true ectoderm, and it has its origin from these cells alone. It commences as a cuticular secretion on the surface of the ectoderm, and afterwards attains its cellular condition by the migration into it of protoplasts formed by proliferation from the ectoderm. These immigrated cells then increase the thickness of the test greatly by forming deposits of cuticular matter around themselves, thus building up the matrix of the adult test. The protoplasts may also develop large vacuoles in their interior, which sometimes increase to such an extent as to form what may be called a bladder-cell—a large oval or globular space in the matrix lined

by a delicate layer of protoplasm, and having a nucleus at one side, the whole of the interior of the cell being a large vacuole. These are found typically developed among the Ascidiidæ (fig. 2, *c.*, and Pl. XXX. fig. 3, *bl.*). Other protoplasts secrete in their interior pigment granules, generally of a dark-brown colour, and this process may be carried to such an extent as to almost entirely obliterate the protoplasm of the cell (fig. 2 *d.*, and Pl. XXIX. fig. 3, *p.c.*). Others, which remain in a less modified condition, are found scattered through the matrix in varying quantities and sizes. They may be fusiform, rounded, stellate, or irregularly branched.

The matrix is usually clear and homogeneous, with a gelatinous or cartilaginous consistency. Frequently, however, it becomes fibrillated in parts, and in some cases, especially amongst the Cynthiidæ, is modified into a fibrous structure, very complicated in the arrangement of its layers, and occasionally continued into simple or branched spine-like projections from the outer surface. In other cases some parts of the test may undergo a sort of cornification, so as to change their appearance and consistency.

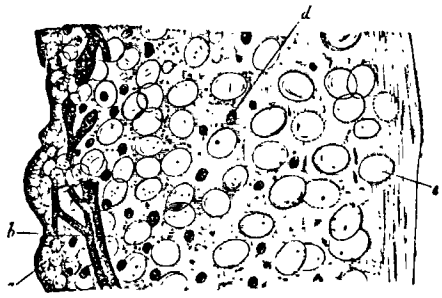


FIG. 2.—Transverse section through the test of *Ascidia*, showing the matrix in which lie large bladder cells (*c*) scattered in the inner layers, and smaller bladder cells (*a*) near the surface (the left side of the figure), blood-vessels (*b*) with terminal knobs, and pigment cells (*d*)—magnified about 40 times.

Usually, especially when it is thick, the test is penetrated by a number of blood-vessels, which are continued out from the body wall into the test, pushing a process of the ectoderm before them. In the adult they enter as two large trunks placed close together, usually near the posterior end of the ventral edge, and these two main stems almost invariably give off corresponding branches which run together, ramifying chiefly in the outer layers of the test (Pl. XXIX., fig. 3), where they end in terminal bulbs, usually by two twigs opening into one bulb, thus allowing the two vessels to communicate.

Spicules have been described as occurring in the tests of various Tunicata. These are probably in most cases post-mortem deposits, but in some species of *Salpa* siliceous spicules appear to be normally present, while in certain of the Ascidiæ Compositæ, large quantities of calcareous deposits are formed in the investing mass, and are in some cases especially developed, as Giard has shown, in autumn, as a protection during the hibernation of the colony.

The Mantle (The Second, Inner, or Muscular Tunic, Muscular Sac).

The second layer covering a Tunicate is the muscular and connective tissue part of the body wall, and lies immediately inside the ectoderm or epidermis. It varies greatly in its characters in different groups, and is to a certain extent a reliable, distinguishing feature, especially for families and genera. It is formed of connective tissue, uniting and enclosing bundles of muscular fibres, nerves, and blood-vessels. In some cases numbers of the connective tissue corpuscles become pigmented, so as to give a coloured or variegated appearance to the mantle.

In the living animal the mantle is in direct union with the ectoderm lying over it (fig. 9, page 40), so that there is no space between the mantle and the test, but in specimens preserved in alcohol the mantle contracts away from the test and leaves a large cavity between, the only points of union being the sides of the branchial and atrial siphons, and the place near the posterior end of the body where the large blood-vessels pass across from the mantle to the test. This separation takes place much more readily in some species than in others, while in some (*Pelonaia corrugata, Polycarpa viridis*, &c.) it apparently never occurs.

The muscular fibres of the mantle are in all cases unstriped. They are either fusiform, or very long filiform fibres, usually more or less united together into bundles. Round the two siphons they are arranged so as to form strong sphincters, sometimes of considerable size (fig. 3, *sph.* page 32).

In the Molgulidæ the mantle is usually thin and membranous, and the muscular bundles have a most characteristic appearance. They are united into short fusiform packets, which present a striking resemblance to the typical form of a muscle in the higher animals; each having a broad central portion or belly, and two long tapering tendon-like extremities. Another characteristic feature of the mantle in the Molgulidæ is the arrangement of a large number of the bundles in lines radiating from the lower edges of the sphincters so as to form a stellate figure round the base of each siphon.

In the Cynthiidæ the mantle attains its greatest thickness, and in some cases the muscular system is developed to an enormous extent. The sphincters are always strong, and the musculature is usually equally developed in the whole mantle, except in some cases in the region over the intestine. The bundles are, as a rule, placed regularly and parallel, forming longitudinal and circular coats. In most typical Cynthiidæ there is an internal circular covered by an external longitudinal coat, and in some (*e.g., Polycarpa varians* and *Styela canopus*) a third internal longitudinal layer is added. In some Bolteninæ the muscular system, though arranged upon the same plan, is so reduced in amount that continuous coats are not formed, and the longitudinal and circular bundles form a network with large rectangular meshes.

In the Ascidiidæ the musculature is much more feebly developed. In typical forms (such as *Ascidia virginea*, O. F. Müller) the muscular fibres are almost entirely confined to the right side of the mantle—the part lying over the branchial sac,—while the left half, over the intestine, is thin and membranous. The bundles run in all directions, branch and anastomose so as to form an irregular network of fibres, meeting at all angles. In the genus *Ciona* the arrangement is more regular. Delicate bundles run circularly, and form a thin non-continuous coat, while much stronger bundles run longitudinally, and are united together into twelve to fourteen strong parallel bands. In *Chelyosoma* the muscular fibres are united into bundles placed between the edges of the horny plates into which the upper part of the test is modified.

In the Clavelinidæ the mantle is thin and the muscular system extremely feeble. The bundles are delicate, and placed far apart, and they run chiefly longitudinally.

In the Ascidiæ Compositæ also, the mantle is thin, and the musculature delicate.

In *Pyrosoma* the mantle is delicate and the muscle bands are confined to the neighbourhood of the branchial and atrial siphons.

In *Doliolum* the muscular fibres are arranged in eight or nine distinct bundles, which form complete hoops encircling the body, and by their contraction expel the water in the branchial and atrial cavities through the terminal apertures; thus propelling the animal through the sea.

In *Salpa* the mantle is thin and tough, and the musculature is developed in the form of a number of strong transverse bands, which sometimes branch and unite, and sometimes remain distinct, but do not form complete hoops as in *Doliolum*. Their arrangement is most definite and characteristic. There are also sphincters round the two terminal apertures.

In the Appendiculariidæ the only muscles known are those of the caudal appendage, where there are two large bundles of striped muscular fibres placed at the sides of the urochord.

Branchial Sac (Pharyngeal Sac, Branchia).

The branchial sac is probably the most important and characteristic organ of the class. It is a modification of the pharynx or first part of the alimentary canal, and differs widely in the different groups, thus affording valuable diagnostic characters. It is usually of considerable size, and in most cases is almost as large as the mantle cavity, while in a few (*e.g.*, *Ascidia mammillata*), it is longer and has the posterior end folded forwards upon the left side of the body. It communicates with the exterior by the branchial aperture or mouth, which is placed anteriorly, and is either circular (*Clavelina*) or surrounded by a definite number of more or less distinct lobes, varying from three (*Culeolus*) up to twelve or fourteen (*Abyssascidia*). The test is prolonged inwards at the edge of the

mouth, and sends down a delicate funnel-shaped prolongation, lining the interior of the mantle tube (fig. 3, *t'.*); consequently the branchial siphon is formed of a tubular process of the mantle containing the sphincter muscle (fig. 3, *sph.*), and both lined and covered by a layer of test substance.

The posterior delicate edge of the lining prolongation from the test, ends against the outer side of a ring-like pad which bounds the lower or posterior end of the branchial siphon. This ring bears a circlet of tentacles (fig. 3, *tn.*) on its lower surface, and varies greatly in its size in different forms. In some (*Microcosmus*) it is produced into lobes, forming a partial diaphragm at the entrance to the branchial sac. The circlet of tentacles is followed by a plain area, the præbranchial zone, which is bounded posteriorly by a pair of closely-placed parallel ciliated ridges, the peripharyngeal bands (fig. 3, *p.p.*). Then comes the wall of the branchial sac proper. This is formed by the union of two membranes —an inner, the wall of the pharynx, and lined by endoderm; and an outer, the inner

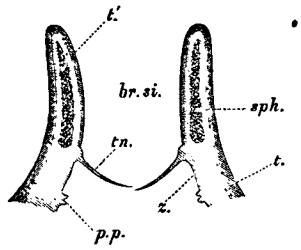


FIG. 3.—Longitudinal section through the Branchial Siphon.
br. si., branchial siphon ; *t.*, test ; *t'.*, prolongation of the test lining siphon ; *sph.*, sphincter muscle ; *tn.*, tentacle ; *z.*, præbranchial zone ; *p.p.*, peripharyngeal bands.

wall of a pair of sacs (the atria) formed primitively of involutions of the ectoderm. The two membranes come into contact, coalesce, and then become absorbed at certain points, so as to leave apertures of communication between the interior of the branchial sac and the surrounding atrial sacs or peribranchial cavity. These apertures, which are in the form of narrow slits known as stigmata, are separated by tubes, the walls of which are formed by the two membranes, and the blood which flows in these vessels is thus brought into close relation with the salt water in the branchial sac, the stigmata, and the peribranchial cavity. The stigmata and vessels vary greatly in their size and arrangement, and thus the structure of the branchial sac gives a number of important characteristics for distinguishing genera and species.

There are three chief systems of vessels present in most branchial sacs. First, the transverse vessels which run round the sac horizontally like parallels of latitude on a globe, and separate the different rows of stigmata (fig. 4, *tr.*). These transverse vessels are most constant, and only differ in calibre. In some sacs they are all of one size, while in

others different sizes alternate. The second set of vessels, the fine longitudinal or interstigmatic, are on the same plane as the transverse vessels, but run longitudinally, separating the different stigmata in a row, and serving as a means of communication between the transverse vessels (figs. 4 and 5, *l.v.*). These interstigmatic vessels are some-

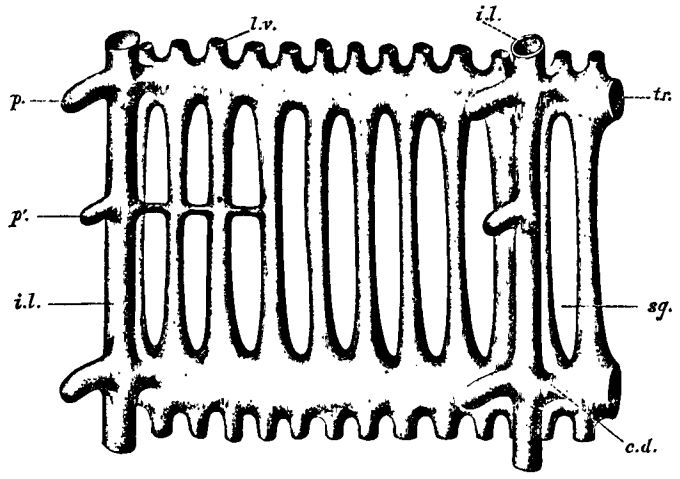


FIG. 4.—A Single Mesh of the Branchial Sac of *Ascidia*, seen from the inside.
tr., transverse vessel ; *i.l.*, internal longitudinal bar ; *l.v.*, fine longitudinal vessel ; *p.*, papilla ; *p'.*, smaller intermediate papilla : *c.d.*, connecting duct.

times very irregular. The third set of vessels, the internal longitudinal (figs. 4 and 5, *i.l.*), occupies a plane internal to the first and second, and consists of a series of stout bars running from the anterior to the posterior end of the branchial sac at right angles to the transverse vessels and communicating with them by short wide connecting ducts

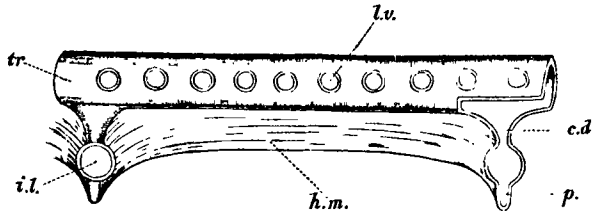


FIG. 5.—Diagrammatic horizontal section through a Mesh of the Branchial Sac of *Ascidia*, showing the interior of the transverse vessel, connecting duct, and papilla at the right hand end.
tr., transverse vessel ; *l.v.*, fine longitudinal vessel ; *i.l.*, internal longitudinal bar ; *p.*, papilla ; *c.d.*, connecting duct ; *h.m.*, horizontal membrane.

(figs. 4 and 5, *c.d.*) placed at the points of intersection. These strong bars are a prominent feature in the branchial sac viewed from the interior, and, along with the transverse vessels, form the boundaries of the rectangular meshes into which the inner surface of the branchial sac is divided.

In the Molgulidæ and Cynthiidæ the whole wall of the branchial sac is thrown into a series of longitudinal folds running from the præbranchial zone to the neighbourhood of the œsophageal aperture. These folds project into the interior of the sac, and are directed towards the dorsal lamina (fig. 6, I.–IV. *br.f.*). They vary greatly in size and number, and in some cases are almost (*Styela grossularia*, &c.) or quite (*Eugyra*) rudimentary. They are especially well developed in the sub-family Cynthinæ, where they are often of very large size, and attain their greatest number on each side (12 or 13, in *Cynthia grandis*, Heller).

On these longitudinal folds the internal longitudinal bars are always more closely placed than they are in the spaces between the folds, and they become more closely placed the nearer they get to the crest of this fold. Hence the meshes become narrower and narrower as one passes along the side of a fold from its base to the crest. As a rule, in the space between two folds, the rows of meshes are all of the same size.

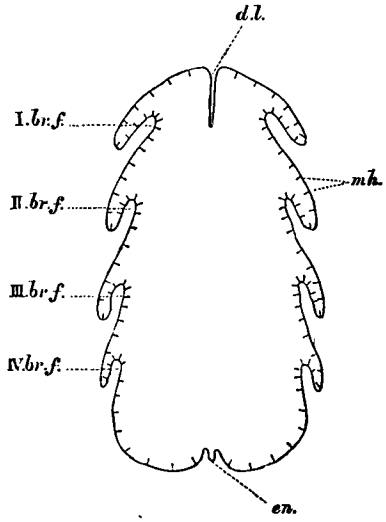


FIG. 6.—Diagrammatic transverse section of the Branchial Sac of *Styela*.
I., II., III., IV. *br.f.*, the branchial folds; *d.l.*, the dorsal lamina; *en.*, the endostyle; *mh.*, one of the meshes.

In the Cynthiidæ the stigmata are longitudinal, and are arranged in regular rows separated by the transverse vessels, but in the Molgulidæ some of the transverse vessels usually become irregularly placed, and branch so as to disturb the regularity of the rows of stigmata. Then the stigmata themselves may become very irregular, as the interstigmatic vessels are usually curved so as to form more or less complete spirals. The different turns of the spiral are united by irregularly placed radiating vessels, thus forming stigmata of different lengths (Pl. VI. fig. 2). This arrangement of spiral interstigmatic vessels and curved stigmata is also found in the genera *Corella*, *Chelyosoma*, and *Corynascidia* among the Ascidiidæ, and attains its greatest development in the genus *Eugyra* (Pl. VI. fig. 8).

In the Ascidiidæ and the Clavelinidæ, there are no large folds in the branchial sac, like those characteristic of the Cynthiidæ and the Molgulidæ, but in many species of the genus *Ascidia*, the interstigmatic vessels are inserted into the large transverse vessels in an undulating, in place of a straight line (see fig. 7, and compare with fig. 5), so that the stigmatic part of the branchial sac, the region between the large transverse vessels, is thrown into a series of slight projections and hollows, which gives the sac a peculiar and complicated appearance, especially from the exterior (Pl. XXVIII. figs. 3 and 4, and Pl. XXXIII. fig. 3), where it is not obscured by the presence of the internal longitudinal bars. This "minute plication" may be further complicated by the transverse vessels being of different sizes, and the slighter ones being involved in the undulations, while the larger ones are not.

In most of the Ascidiidæ the internal longitudinal bars are provided on their inner surfaces with papillæ or knob-like projections (figs. 4 and 7, *p.*) placed at the points of intersection with the transverse vessels, and immediately opposite the connecting ducts; and the broad membranes which hang from the front of the transverse vessels (figs. 5 and 7, *h.m.*) are attached to the side of these papillæ and stretch between them like horizontal shelves. In some species of *Ciona* and *Ascidia* one or two apertures of communication with the peribranchial cavity, in addition to the ordinary stigmata, have been found. They are comparatively long slits, in the posterior dorsal region, usually one on each side of the dorsal lamina near its posterior end, and are bordered by cilia much finer than those of the ordinary stigmata.

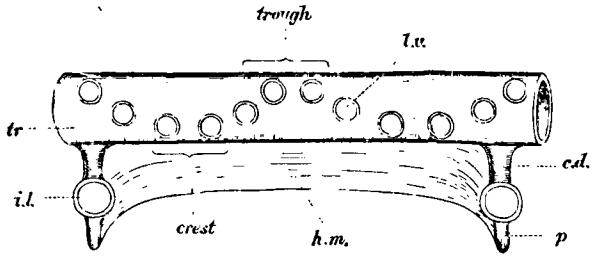


FIG. 7.—Diagrammatic horizontal section through a Mesh of the Branchial Sac of *Ascidia*, showing the arrangement of the fine longitudinal vessels which causes "minute plication."

tr., transverse vessel; *l.v.*, fine longitudinal vessel; *i.l.*, internal longitudinal bar; *c.d.*, connecting duct; *p.*, papilla; *h.m.*, horizontal membrane. "Crest" indicates the highest, and "trough" the lowest part of the undulation.

In the Clavelinidæ, the branchial sac is neither folded nor plicated, and there are no papillæ on the internal surface. In the genus *Clavelina* the entire system of internal longitudinal bars is absent.

In the Ascidiæ Compositæ the branchial sac is always simple in structure, differing little in most forms (*e.g.*, *Botryllus*) from the arrangement found in *Clavelina*. In some cases, however, internal longitudinal bars are found, and occasionally these bear slight papillæ (*Distoma*, *Diazona*).

In *Pyrosoma* the sac is formed by a series of transverse interstigmatic vessels, and of internal longitudinal bars intersecting at right angles.

In *Doliolum* the stigmata may either be confined to the posterior region of the sac, as in *Doliolum mülleri*, or may extend forward, as in *Doliolum denticulatum*.

In *Salpa* the branchial sac is greatly modified and reduced to a branchial "band," which represents the dorsal lamina. The systems of vessels uniting this dorsal band to the endostyle are entirely absent, so that each half of the sac is converted into a single large stigma.

In the Appendiculariidæ there are only two stigmata, one on each side of the endostyle, near the posterior end. They lead by atrial canals, which represent the right and left sides of the peribranchial cavity, to the exterior. The endoderm cells lining the branchial sac are ciliated, and larger cilia are present along tracts corresponding to the peripharyngeal bands and the dorsal lamina, and around the edges of the two stigmata.

The Peripharyngeal Bands (Pericoronal Ridges, Ciliated Arcs).

The position of the peripharyngeal bands at the anterior end of the branchial sac has already been pointed out. They lie at the base of the branchial siphon, and the anterior band, or, as Julin calls it, the internal lip of the groove, forms a complete ring, bounding the præbranchial zone posteriorly. The posterior band or external lip, on the contrary, is complete only at the sides. At the ventral end its right and left halves turn posteriorly, and become directly continuous with the marginal ridges of the endostyle; while dorsally they are continued into the anterior end of the dorsal lamina.

The peripharyngeal bands are formed of ridges of connective tissue continuous with that of the mantle, and covered on their free surfaces with epithelium, which changes gradually from low columnar in the groove to cubical and then squamous on the outer slopes, where the ridges become continuous with the præbranchial zone on the one hand, and with the inner surface of the branchial sac, on the other. The cells covering the floor of the groove, and those along the most prominent parts of the ridges, bear very short cilia, while the anterior and posterior slopes of the ridges and the sides of the groove are not ciliated.

The Endostyle (Hypobranchial Groove).

This organ forms the ventral edge of the branchial sac, and extends from the peripharyngeal bands anteriorly to the posterior end of the sac. It is a groove bounded by parallel lips, often of considerable height, and projecting into the cavity of the branchial sac (fig. 8). The groove is lined by a modification of the epithelium of the interior of the branchial sac, and is in some parts cubical, and in others columnar and ciliated.

Fol's[1] investigations have established that the endostyle is an organ for the secretion of mucus, which is carried upwards to the anterior end of the sac by the action of the long cilia on the floor of the groove. It reaches the dorsal lamina, where, along with

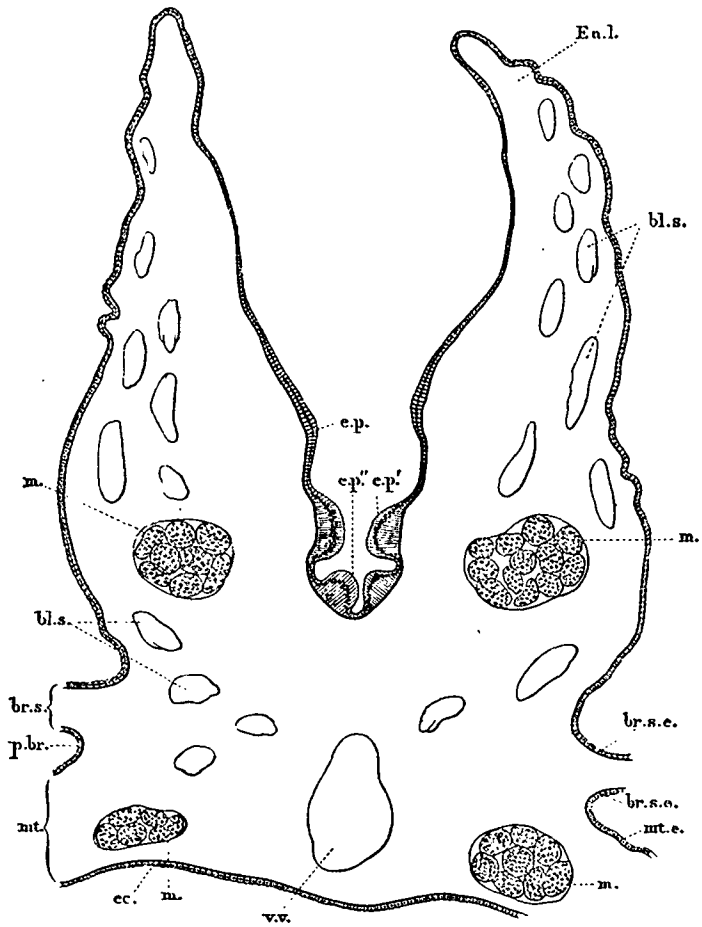


FIG. 8.—Transverse section of the Endostyle of *Molgula gigantea.*

br.s.e., epithelium lining branchial sac; *br.s.e'.*, epithelium on outer side of branchial sac; *mt.e.*, epithelium lining mantle; *ec.*, ectoderm; *mt.*, mantle; *br.s.*, wall of branchial sac; *En.l.*, lip of endostyle groove; *ep.*, 1st epithelial pad on inner lip of endostyle; *ep'.*, 2nd epithelial pad; *ep''.*, 3rd epithelial pad; *m.*, transverse section of inner bundles of muscular fibres; *m'*, transverse section of outer bundles of muscular fibres; *v.v.*, great ventral vessel; *bl.s.*, small blood sinuses; *p.br.*, peribranchial chamber.

entangled food-particles, it forms a long string, extending down to the œsophagus, by being carried round the peripharyngeal groove, lying between the two peripharyngeal bands.

The endostyle is remarkably similar in all the Tunicata, and very rarely furnishes characters which can be made use of in classification.

[1] Ueber die Schleimdrüse oder den Endostyl der Tunicaten. *Morphol. Jahrbuch.*, Bd. i., p. 223, 1874.

The Dorsal Lamina (Oral Band, Ventral Plait, Epibranchial Fold, Languets).

This structure occupies the region of the branchial sac directly opposite to the endostyle, and marks the dorsal edge.

In the majority of Simple Ascidians it is present in the form of a membrane of varying breadth, according to the species, which commences anteriorly by the union of two pads which converge from the dorsal ends of the posterior peripharyngeal band, and are separated by a groove, called by Julin the "epibranchial groove." This groove is also of varying length, according to the species. In some (*e.g.*, *Corella parallelogramma*) it is comparatively short, while in others (*e.g.*, *Ascidia venosa*) it is of considerable length. Although it frequently approaches close to the two halves of the peripharyngeal groove, it appears to be always completely shut off from both by the union of the two sides of the posterior peripharyngeal band. It is only this first or anterior portion of the dorsal lamina which is united to the mantle; the rest of it is free, the branchial sac being in this region separated from the mantle by the dorsal part of the peribranchial cavity. The epibranchial groove is lined in its entire extent with low columnar ciliated epithelium. Behind the epibranchial groove the dorsal lamina usually widens gradually as it approaches the œsophageal aperture, and then narrows suddenly, and terminates in a low ridge leading round the posterior end of the sac to join the extremity of the endostyle.

The dorsal lamina has, especially in its posterior broader part, the free edge somewhat bent round, usually to the right but sometimes to the left side (fig. 9, p. 40), so as to form a semi-canal leading down to the œsophageal aperture, and it is along this groove that the string of food-particles agglutinated with mucus passes on its way to the œsophagus. The left (convex) side[1] of the lamina is in many species marked by a series of more or less distinct transverse ridges or ribs, usually corresponding to the transverse vessels and the horizontal membranes of the branchial sac, and crossing from the base to the free edge, where they frequently terminate in projecting teeth or knobs (Pl. XXXI. fig. 7).

In different species the dorsal lamina differs considerably in its breadth and the presence and amount of development of ribs and teeth—the length depends upon the position of the œsophageal aperture.

In several genera of the Ascidiidæ (*Ciona, Corella, Abyssascidia, Chelyosoma,* and *Corynascidia*) the dorsal amina is represented by a single, or in some cases a double, series of triangular flaps or tapering finger-like processes named languets (Pl. XXV. fig. 7, Pl. XXVI. fig. 7, and Pl. XXXIV. fig. 9). These are also found in the Clavelinidæ and in some of the Cynthiidæ (*e.g.*, *Cynthia* and rarely *Styela*). In some cases the languets are united together at their bases by a narrow membrane, so as

[1] Sometimes both sides are ribbed transversely.

to resemble the ordinary dorsal lamina, with greatly exaggerated marginal projections. In other cases there is no membrane, and the languets are quite disconnected.

In Compound Ascidians and in *Pyrosoma*, languets are present, forming a series along the dorsal edge of the sac, as in *Ciona*; while in *Salpa* there is a single very large languet near the anterior end in the dorsal region. Behind this there is a membranous band (the "gill") representing the remainder of the dorsal lamina, and extending posteriorly and ventrally to join the posterior end of the endostyle, and thus separate the branchial sac from the cloaca.

The Peribranchial Cavity (The Respiratory Chamber, the Atrium, the Cloaca).

The peribranchial cavity or atrium is the space surrounding the branchial sac and communicating with the exterior by the atrial aperture, which is usually placed on the dorsal surface not far from the anterior end, but may move backwards so as to lie at a considerable distance from the branchial aperture, or even at the posterior end of the body, as in *Pyrosoma*, *Salpa*, *Doliolum*, *Botryllus*, *Culeolus*, &c. This atrial or exhalent aperture terminates a short tubular process of the mantle, just as in the case of the branchial aperture; and this atrial siphon is also provided with a sphincter muscle, a lining prolongation from the test, and sometimes a partial diaphragm at its lower end, but there is no tentacular circlet.

The peribranchial cavity is formed in the embryo by two lateral epiblastic involutions, which unite dorsally, and surround the branchial sac, except along its ventral edge, where the two lateral halves of the peribranchial cavity are separated by the union of the endostyle to the mantle (fig. 9, p. 40). The epithelium which lines the two atrial involutions forms in the adult Ascidian the "lining membrane" of the atrium, or the "third tunic" of Milne-Edwards, and is divided into the parietal layer lining the mantle (fig. 9 *mt.e.*) and forming the outer walls of the cavity, and the visceral layer covering the branchial sac and constituting the inner wall. The cavity is crossed by blood-vessels connecting the branchial sac with the sinuses in the mantle (fig. 9 *con.*). Besides these, called "connectives" by Hancock, the branchial sac is united to the mantle by the œsophagus, along the entire length of the endostyle, round the anterior end at the peripharyngeal bands, and along the first portion of the dorsal lamina.

The peribranchial cavity is in free communication with the interior of the branchial sac through the stigmata, and is traversed by the water in its course to the atrial aperture. The anus and the genital ducts open into the peribranchial cavity in the dorsal median region, often called the cloaca. Consequently the epithelium of the peribranchial cavity (the "lining membrane") is continuous with the endoderm of the branchial sac at the stigmata and of the rectum at the anus, and also with the epithelium lining the genital ducts.

In the Appendiculariidæ the peribranchial cavity is represented by two "atrial canals," which connect the two stigmata of the branchial sac with the exterior. They lie on the ventral side of the sac at the sides of the endostyle, and the apertures are near the middle of the ventral surface close to the anus. A similar condition of parts is found at a comparatively late stage of development in Simple Ascidians, and the single peribranchial cavity of the adult is the result of the fusion of the two atria, into one of which the

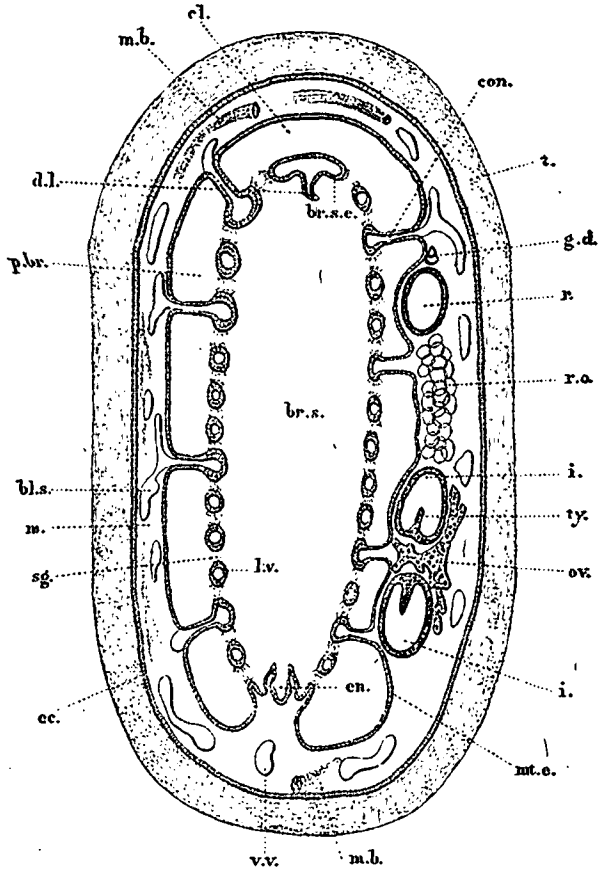


FIG. 9.—Diagrammatic transverse section through the middle of the body of *Ascidia*.

t., test; *ec.*, ectoderm; *m.*, mantle; *m.b.*, muscle-bands in mantle; *bl.s.*, blood sinus in mantle; *v.v.*, great ventral vessel; *mt.e.*, epithelium lining the peribranchial cavity; *p.br.*, peribranchial cavity; *cl.*, cloaca; *br.s.*, cavity of branchial sac; *l.v.*, longitudinal vessel of branchial sac; *sg.*, stigma; *en.*, endostyle; *br.s.e.*, epithelium lining branchial sac; *d.l.*, dorsal lamina; *con.*, connective between branchial sac and mantle; *i.*, section of intestine; *ty.*, typhlosole; *ov.*, ovary; *r.o.*, renal organ; *r.*, section of rectum; *g.d.*, section of genital ducts.

anus has come to open. The common aperture finally moves to the dorsal surface of the body; consequently the dorsal atrial aperture of the Ascidian represents the three ventral apertures of *Appendicularia*.

Tentacles (Branchial Filaments).

The tentacles have been already referred to, and their position at the posterior end of the branchial siphon described (fig. 3, *tn.*, p. 32). They are hollow processes, not of the involuted test but of the wall of the alimentary canal, and of the mantle, as these two are in contact in that region, the peribranchial space not extending so far forward. The epithelium covering the tentacles is continuous with that of the præbranchial zone, while the connective tissue underneath, usually containing muscle bands, is in connection with that of the mantle. Blood sinuses from the latter are also prolonged up the centre of the tentacles, so that the blood circulates in their interior.

They vary greatly in size and shape in different genera and species, and very frequently they are of different sizes, arranged symmetrically. In a few cases (*e.g.*, *Culeolus wyville-thomsoni* and *Molgula pedunculata*) one of the tentacles is very much larger than any of the others.

In the Molgulidæ the tentacles are always compound, and are usually much branched, in some of the larger species (*e.g.*, *Molgula gigantea*) forming huge complicated arborescent masses. Their number in the Molgulidæ is never very great. A not uncommon arrangement is for seven or eight large tentacles to alternate with the same number of smaller ones.

In the Cynthiidæ we find a great variety of tentacles. Two of the sub-families, the Bolteninæ and the Cynthinæ, have compound tentacles very similar to those of the Molgulidæ, but usually more numerous, while the third sub-family, the Styelinæ, has simple unbranched tentacles like those of the Ascidiidæ, but frequently wider at the base, and having a more inflated appearance.

In both the Ascidiidæ and the Clavelinidæ they are also simple, and present the form of long tapering processes, usually distinctly triangular in cross section, and placed with a flat surface anteriorly, and a ridge posteriorly. Among the Ascidiidæ we frequently meet with complex arrangements. The tentacles may be of different sizes, two, three, or more orders being placed alternately.

In the Ascidiæ Compositæ the tentacles are invariably simple, and few in number. They are usually all of the same length, although in some cases (*e.g.*, *Botryllus*, where there are four larger alternating with four smaller) two orders occur.

In the Appendicularii dæ, the Pyrosomidæ, and the Thaliacea the tentacles seem to be entirely absent.

Nervous System.

A single large nerve ganglion is found in all Tunicata placed between the branchial and atrial siphons, and is usually considered as indicating the dorsal surface of the

animal. It lies in the mantle near its inner surface, underneath the muscular layers, and above the neural gland.

It has usually an oblong form, slightly constricted in the middle, and giving off nerve trunks from the expanded ends, one of which is directed anteriorly and the other posteriorly.

In the Ascidiæ Simplices, where the branchial and atrial apertures are usually approximated, the nerve ganglion lies in the angle between them, almost invariably nearer the branchial than the atrial aperture (the reverse is the case in *Ascidia compressa* and *Ascidia fusiformis*), and the anteriorly and posteriorly directed nerve trunks run directly to the neighbourhood of the apertures, and give off branches to the tentacles, the ocelli, and the margins of the lobes.

In *Appendicularia* there is a large ganglion, with three dilatations, placed in the usual position on the dorsal side of the anterior end of the pharynx, and giving off, in addition to nerves to the branchial aperture, a long nerve trunk, which runs back alongside the œsophagus and past the stomach till it reaches the base of the caudal appendage. Here it goes to the left side of the urochord, along which it runs to the extremity, giving off nerves from ganglionic enlargements which occur at intervals. The most anterior of these caudal ganglia is the largest. Fol states that this gangliated nerve trunk is traversed by a fine canal.

The periphery of the ganglion is formed of globular or pyriform unipolar nerve cells, while the centre is a mass of nerve fibres, with a very few small nerve cells scattered through it. The nerve trunks arise from this central fibrous part.

Sense Organs.

In the adult Simple and Compound Ascidians the only structures which can be called sense organs—now that the sensory nature of the so-called "olfactory tubercle" has been disproved—are the tentacles round the base of the branchial siphon, which have probably some sensory function, and the ocelli or pigment spots situated around the branchial and atrial apertures. They are usually equal in number to the lobes surrounding the apertures, and are situated in the clefts between them. The pigment, which is almost invariably red, is imbedded in the mantle just above the anterior edge of the sphincter muscle, where the test is usually thin and transparent, and is supplied by branches of the nerve trunks from the anterior end of the nerve ganglion.

In *Appendicularia* there is a rounded otocyst, containing a spherical otolith, attached to the main ganglion, while Fol has described a number of fine tactile setæ situated around the branchial aperture. In some forms of *Doliolum* there is also a spherical otocyst, containing a single otolith and supplied by a nerve from the ganglion.

In the lobes around the branchial aperture in *Doliolum*, in *Salpa*, and probably in other forms also, there are certain modified ectodermal cells, which appear to be nerve-endings. They have filamentous processes which extend to the surface, and these have probably a tactile function.

In *Pyrosoma* there is a visual organ formed of an outgrowth from the nerve ganglion, covered with pigment and having a refracting body imbedded in it; and in *Salpa* there is a similar organ also placed upon the ganglion.

The Neural Gland and Duct (The Hypophysial Gland, the Olfactory Gland).

Underneath the nerve ganglion, and imbedded in the innermost layer of the mantle, lies a gland first noticed by Hancock in 1868, afterwards more fully examined by Ussow

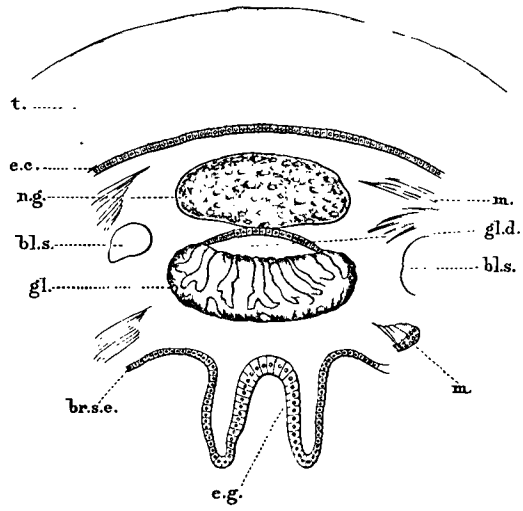


FIG. 10.—Diagrammatic transverse section through the dorsal region of the anterior end of a Simple Ascidian.
t., test; *ec.*, ectoderm; *n.g.*, nerve ganglion; *m.*, muscle bands; *bl.s.*, blood sinus; *gl.*, subneural gland; *gl.d.*, duct of the gland; *br.s.e.*, epithelium lining the branchial sac; *e.g.* epibranchial groove.

and Nassonoff (who first demonstrated its glandular nature), and brought prominently into notice lately by Julin.[1] According to this author the neural gland corresponds to the pituitary gland of the vertebrate brain, and retains by means of its duct, to be presently described, that primitive connection with the pharynx which is lost in higher forms.

In structure it is a tubular ramified gland (fig. 10 *gl.*) having a number of cæcal tubes lined by cubical epithelium, and surrounded by connective tissue containing a very large number of blood sinuses. The cæca all converge towards the ventral surface of

[1] Julin, Arch. de Biologie, t. ii. p. 59, 1881.

the duct and open into it in its posterior half or three-fourths, the glandular epithelium of the tubes being continuous with the epithelium of the duct.

As to the function of the neural gland, van Beneden's recent suggestion that it is a renal organ in connection with the nervous centre seems probable, and is supported by the case of *Ascidia mammillata*, where the apertures of the numerous secondary ducts or infundibula open into the peribranchial space.

The duct (figs. 10 and 11, *gl.d.*) is delicate, and is lined by a single layer of cubical epithelium. It runs anteriorly, directly under the front part of the nerve ganglion

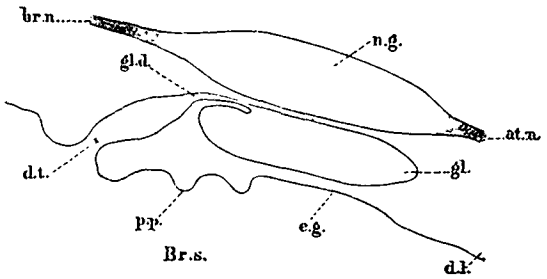


FIG. 11.—Diagrammatic longitudinal vertical section through the dorsal region of the anterior end of a Simple Ascidian. *br.n.*, branchial nerve; *at.n.*, atrial nerve; *n.g.*, nerve ganglion; *gl.*, subneural gland; *gl.d.*, duct of the gland; *d.t.*, dorsal tubercle; *p.p.*, peripharyngeal band; *e.g.*, epibranchial groove; *d.l.*, dorsal lamina; *Br.s.*, branchial sac.

and above the anterior part of the dorsal lamina, till it terminates by a complicated aperture best known as the olfactory or dorsal tubercle (fig. 11, *d.t.*), situated in the dorsal region of the anterior end of the branchial sac.

The Dorsal Tubercle (The Anterior Tubercle, the Branchial Tubercle, the Ciliated Organ, the Olfactory Tubercle.)

This, the aperture of the duct from the neural gland, is situated in a diverticulum from the præbranchial zone, the peritubercular area, formed by the bending posteriorly of the right and left peripharyngeal bands before they join at the anterior end of the dorsal lamina. Primitively, there is little doubt, it was in the form of a simple circular opening probably with prominent edges. It is still found in this or a very slightly modified form in *Molgula pyriformis* and *Eugyra kerguelenensis*. In most cases, however, the aperture is found in a much more complicated condition. This seems to have resulted from a forcing backwards of the anterior part of the edge till it almost came in contact with the posterior part, thus reducing the circular aperture to a slit curved in the form of a semicircle, with its concavity directed forwards, and bounded by prominent lips, usually more conspicuous than the aperture. This stage is found in *Ascidia scabra*.

Further complications are produced by the lips round the ends of the slit or "horns," as they may be called, being greatly prolonged and bent or coiled in various directions.

Sometimes both horns are coiled inwards towards each other, sometimes outwards, and in other cases they curve in opposite directions. The resulting forms seem almost endless, and although the dorsal tubercle affords in some cases characters of value in classification, still it cannot be relied upon, and in many species (*e.g.*, *Ascidia virginea* and *Styela grossularia*) exhibits a considerable amount of individual variation.[1]

In a few cases the dorsal tubercle is still further complicated, apparently by the development of lateral branches from the original slit as in *Boltenia pachydermatina* (Pl. VII. fig. 8), while in *Cynthia irregularis* (Pl. XVI. fig. 12) the primitive aperture has evidently become subdivided into a number of openings, each bounded by prominent lips.

In those cases where the organ is complicated, and has a pair of closely coiled spiral horns, the raised lips of the aperture make a considerable projection, and give the appearance of a tubercle with a curiously sculptured surface (as in *Ascopera gigantea*, Pl. III. fig. 5). For a long time this was considered from its appearance, its proximity to the nerve ganglion, and its position at the entrance to the branchial sac, as a sense organ, and was hence called the olfactory tubercle. Ussow and Julin have, however, definitely established (1), that the tubercle is not sensory, and has no nervous connection with the ganglion; and (2), that it is simply the aperture by which the duct of the neural gland communicates with the branchial sac.

The slit forming the aperture leads into a funnel-shaped cavity (fig. 11, *d.t.*), the commencement of the duct, and this is lined by an epithelium of columnar cells provided with very long cilia. This is replaced by cubical non-ciliated cells on the lips of the aperture, and that graduates into the squamous epithelium covering the surface of the præbranchial zone. Under the epithelium is a layer of connective tissue continuous with that of the mantle.

The Alimentary Canal.

The first portion of the alimentary canal, consisting of the mouth and pharynx, has already been fully described as the branchial aperture, the siphon, and the branchial sac. The next portion, or alimentary canal proper, consisting of the œsophagus, stomach, and intestine, commences with the œsophageal aperture, placed near the posterior extremity of the dorsal lamina, and terminates in the anus, which opens into the dorsal part of the peribranchial or atrial cavity—the large space surrounding the branchial sac.

The stomach and intestine almost invariably lie at one side of the branchial sac, usually the left, and may either be comparatively free or attached along the whole extent to the inner surface of the mantle, and covered by the layer of squamous epithelium lining

[1] See Herdman, On the Olfactory Tubercle as a Specific Character in Simple Ascidians, Proc. Roy. Phys. Soc. Edin., vol. vi. p. 254, 1881.

the peribranchial cavity, and forming the "lining membrane" of Hancock (the "third tunic" of Milne-Edwards) (see fig. 9, page 40).

The typical arrangement among Simple Ascidians (*e.g.*, *Ascidia mentula*) is for the œsophagus to run posteriorly and ventrally from the branchial sac, to open into the large fusiform, globular, or cylindrical stomach, which extends towards the ventral edge of the mantle cavity (fig. 12). The intestine emerges from the most ventral and anterior part of the stomach, and runs anteriorly for a short distance, and then turns dorsally and posteriorly, so as to point towards the stomach. Before reaching that organ, however, it bends dorsally and then anteriorly, becoming the rectum, which runs forwards near the dorsal edge of the peribranchial cavity to terminate in the anus, usually situated near the atrial aperture (fig. 12, *a*, and fig. 1, page 27).

This arrangement prevails with slight modifications throughout the genera *Ascidia* and *Pachychlæna*. In *Ciona*—a simpler form—the stomach and part of the intestine lie posteriorly to the branchial sac, and the rest of the intestine has a straighter course than is the case in *Ascidia*. In the genus *Corella* the alimentary canal lies at the right side of the branchial sac, and the intestine turns posteriorly on leaving the stomach. After a very short course it bends dorsally, and after running parallel to the stomach and œsophagus it turns anteriorly, and becomes the rectum. Consequently the three genera—*Ascidia*, *Ciona*, and *Corella*—have the relations of the branchial sac and the intestine very different. *Ciona* seems to be the more primitive form, from which the other two may have been derived.[1] In *Abyssascidia* the arrangement is much the same as in *Corella*, but the entire canal is more closely packed at the posterior end of the body (Pl. XXVII. fig. 3).

In most of the Clavelinidæ the arrangement resembles that found in *Ciona*. In the genera *Clavelina*, *Ecteinascidia*, and *Rhopalæa*, the intestine is greatly prolonged posteriorly to the branchial sac, so as to form a fairly distinct region of the body, named by Savigny the abdomen. In *Perophora*, on the other hand, there is no distinct abdomen, the intestine having become drawn up alongside the branchial sac on its left side.

In the Cynthiidæ there is considerable variation in the situation, length, and disposition of the intestine. Probably the simplest condition is that found in *Culeolus* among the Bolteninæ. Here the atrial aperture has retained what is probably its primitive position, at or near the posterior end of the body (Pl. VIII. fig. 8), and consequently the anus opens in that region of the peribranchial cavity, thus dispensing with the long anteriorly running rectum so well developed in *Ascidia*. Consequently the intestine, after leaving the stomach, merely turns forwards and then backwards again towards the atrial aperture.

In the Molgulidæ the stomach and intestine lie upon the left side of the branchial sac, and form a single, transversely directed, narrow loop, the posterior segment of which is

[1] See Herdman, Notes on British Tunicata, Jour. Linn. Soc., Zool., vol. xv. p. 274, 1880.

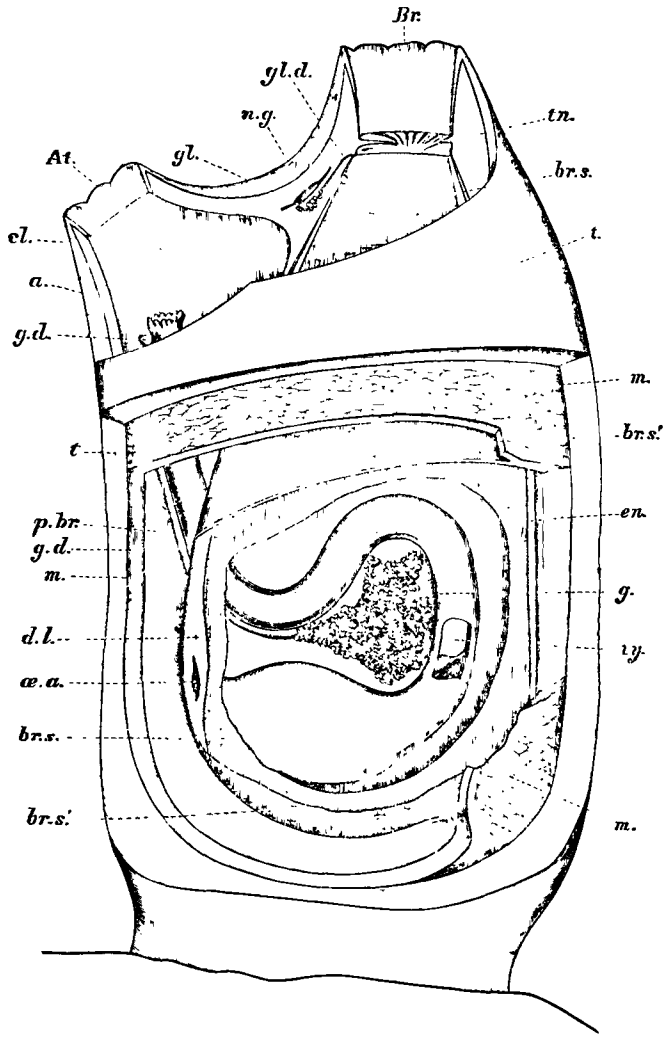


FIG. 12.—Diagram of a dissection of *Ascidia*, from the right side, to show the relations of the different "tunics" and cavities, the course of the alimentary canal, &c.

Br., branchial aperture; *At.*, atrial aperture; *t.*, test; *m.*, mantle; *br.s.*, branchial sac; *br.s'.*, outer surface of branchial sac; *en.*, endostyle; *d.l.*, dorsal lamina; *p.br.*, peribranchial cavity; *tn.*, tentacle; *cl.*, cloaca; *œ.a.*, œsophageal aperture; *ty.*, typhlosole in intestine; *a.*, anus; *n.g.*, nerve ganglion; *gl.*, neural gland; *gl.d.*, duct from neural gland; *g.*, genital organs; *g.d.*, genital duct.

constituted by the œsophagus, the stomach, and the first portion of the intestine, while the second portion forms the anterior segment of the loop, lying close to and parallel with the posterior. From the dorsal end of this second portion of the intestine a short rectum usually runs anteriorly towards the atrial aperture. Sometimes the loop of the intestine is so long that, after extending to the ventral edge of the body, it is turned round anteriorly and then dorsally, so as to almost completely surround the left genital mass (Pl. V. fig. 9), which lies anteriorly to the intestine.

In the Ascidiæ Compositæ the stomach and intestine always project beyond the branchial sac, but to very different degrees in different forms. In *Botryllus* they are close to the branchial sac, and there is no distinct abdomen; while in *Amaroucium* and a number of allied genera the intestine projects for a long way behind the branchial sac, and an abdomen as long as, or longer than, the thorax is formed. *Botrylloides, Didemnum,* and some other genera, show a state of affairs intermediate between these extremes. In all these forms the œsophagus commences near or at the posterior end of the branchial sac at the dorsal side, and after running posteriorly for a short distance opens into the stomach. The intestine emerging from the opposite end of this organ still runs posteriorly for a short distance, and then turns round towards the ventral side to run anteriorly. It afterwards crosses the œsophagus, so as to become dorsal again in its last part, which opens as usual into the peribranchial cavity.

In *Pyrosoma,* the alimentary canal is placed transversely at the posterior end of the branchial sac, but on account of the position of the atrial aperture at the opposite extremity of the body from the branchial, the intestine bends round posteriorly so as to describe a circle.

In the Thaliacea the digestive canal and genital glands are usually aggregated into a small mass, the "nucleus," placed in the ventral region of the posterior end of the body.

In *Appendicularia* the œsophagus commences at the narrow posterior end of the branchial sac, and leads ventrally towards the large stomach, which lies transversely and has two lobes, a right and a left. The latter gives rise to the intestine, which turns forwards as a short rectum and terminates in an anus placed on the exterior of the body about the middle of the ventral surface.

In many Tunicates the wall of the intestine is raised up to form a fold, which projects into the lumen (fig. 9, page 40, and fig. 12, *ty.*, page 47). This "typhlosole" varies somewhat in its development in different species, extending throughout the entire intestine in some (*Styela tuberosa*), while in others it is only present in a part of it. The connective tissue underneath the endoderm and forming the centre of the fold usually contains large blood-vessels.

Several glandular appendages are found in connection with the alimentary canal in the Tunicata, and are, like a number of nondescript organs in other groups of the Invertebrata, usually referred to as the liver.

In the Molgulidæ there is a well-developed glandular mass, usually divided into several lobes, which, in the absence of definite information as to its function, may be called a liver. A similar organ is found coating the stomach in many of the Cynthiidæ, and in other forms, and in some of the Ascidiidæ and some Ascidiæ Compositæ there are thickenings of the wall of the stomach, which are possibly a less developed form of the same organ.

In many other cases, including Simple and Compound Ascidians, and also *Salpa*, *Doliolum*, and *Pyrosoma*, there is present a system of fine tubules ramifying over the stomach and part of the intestine. The tubules in all cases are colourless and highly refracting, branch dichotomously, and unite into one or two larger tubes, which open into the pyloric end of the stomach, or the first portion of the intestine.

This organ has been known since the time of Savigny, and has been considered by some authors as a liver, by some as a system of lacteals, and by others as part of the circulatory apparatus. In some cases (some species of *Salpa*) a simple network of tubules is formed by the dichotomous branching of the main duct, the twigs anastomosing freely. In other cases (*Salpa*, *Pyrosoma*, *Ascidia*) a similar network is formed, but all the twigs terminate in pyriform enlargements or ampullæ, which are scattered over the meshes and give a characteristic appearance to the system. In other forms again (*Ascidia*, *Clavelina*, *Perophora*, and various Compound Ascidians) the tubules do not anastomose, but merely branch freely and finally end in ampullæ. Chandelon (1875) examined this organ minutely in *Perophora*, and found that the walls of the tubules were formed of a single layer of cubical or low columnar cells, placed upon an apparently structureless basement membrane. The cells are distinctly nucleated and sometimes granular, and bear short cilia projecting into the lumen of the tubule. He also found that the terminal ampullæ frequently contain highly refracting rounded concretions.

The function of this system is still rather enigmatical. Chandelon considers that it is neither renal nor hepatic, but that it must be considered as a digestive gland, secreting a clear fluid which flows into the intestine, but the exact action of which is at present unknown.

Renal Organs.

Several different organs have been recognised in the Tunicata as having a renal function. In the Molgulidæ there is a sac-like, usually sausage-shaped organ (Pl. IV. fig. 7, *r.o.*), lying on the inner side of the mantle on the right side of the body, posterior to the genital mass of that side, and separated by the lining membrane from the peri-branchial cavity. It lies alongside the pericardium in its entire extent, and undoubtedly eliminates waste products from the blood. These are not expelled from the body, but are stored up in the form of usually rounded or nodulated concretions which, as was first shown by Kupffer in 1872, contain uric acid. Huxley (Manual of the Invertebrata, 1877)

considers that this body may be regarded as the representative of the glandular portion of the organ of Bojanus.

In some of the Molgulidæ (the genus *Lithonephrya* of Giard) this renal organ is always found occupied by a single large concretion, which almost entirely fills its cavity.

In many of the Ascidiidæ we find another kind of renal apparatus. A large number of huge clear-walled spherical vesicles are aggregated together in a mass lying around the intestine, and in the thickness of the mantle (fig. 9, *r.o.*, p. 40), while a number of small blood-vessels and sinuses ramify through the mass. As in the case of the Molgulidæ, there is no excretory duct, and the elimination products are stored up in the thin-walled vesicles in the form of spherical concretions concentrically laminated, and sometimes having shells of different tints of yellow and brown, and are usually covered by a thickish coating of a pure chalky white. These concretions contain a considerable amount of uric acid.

Finally, as has been stated above, E. van Beneden and Julin have shown strong grounds for the belief that the neural gland is a renal organ, especially devoted to the nerve ganglion. If this be the case, then this gland differs totally from the other renal organs in the Tunicata, inasmuch as it possesses a duct by which the eliminated substances are excreted either into the branchial sac or the peribranchial cavity.

Blood-Vascular System.

The heart in the Tunicata is a simple sac or fusiform tube, from the two ends of which vessels are given off. It is enclosed in a delicate membranous sac, the pericardium, formed, according to Hancock, of a fold of the lining membrane of the peribranchial cavity, to which it is attached along one side from end to end.

In all Tunicates in which the matter has been investigated, the periodic reversal of the blood current, first noticed by Kuhl and van Hasselt in the case of *Salpa* has been found. The heart, after contracting for a certain time in one direction, stops, and then the waves of contraction begin to pass along it in the opposite direction, consequently the blood is propelled from the dorsal and ventral ends of the heart alternately. In the young *Ascidia virginea* there are usually from 35 to 40 contractions in one direction at a time, and this takes from 1 min. 30 sec. to 2 min., while the pause between the two series of contractions is usually 7 or 8 seconds in duration, and thus equals three ordinary contractions.

The heart varies considerably in position in different forms. In the Molgulidæ it is placed on the right side, and adheres to the inner surface of the mantle immediately anterior to the renal organ.

In the Cynthiidæ, as a general rule, it lies in close relation to the stomach or the first portion of the intestine, but in the curious *Culeolus*, it is situated on the right side of the body, close to the endostyle, and attached to the inner surface of the mantle.

In *Ascidia* the heart lies upon the left side of the body, along the posterior edge of the stomach, while in *Ciona* it is also in close relation to the stomach, but runs more antero-posteriorly than in *Ascidia*, on account of the changed relations of the alimentary canal. In *Corella* the heart is placed comparatively far forwards, being situated upon the anterior border of the stomach, and consequently upon the right side of the body.

In *Clavelina* the heart is placed in the abdomen, and runs antero-posteriorly along the side of the stomach on its inner edge.

In the Ascidiæ Compositæ the heart varies somewhat in position in different groups, and, according to Milne-Edwards, is always in close relation to the generative organs. In *Botryllus*, where there is no abdomen developed, both heart and genitalia are situated close to the posterior part of the branchial sac, the heart being on the left side. In *Didemnum* and some allied forms, the heart runs alongside the stomach on the right side of the abdomen, while in *Amaroucium* and a number of other genera, the heart and the genital organs form a long projection, extending far beyond the intestine, and known as the post-abdomen.

In *Pyrosoma* the heart is placed towards the posterior end of the ventral edge of the branchial sac, and near the stomach.

In *Salpa* the heart is large, and is situated close to the visceral nucleus on its anterior and ventral sides.

In the Appendiculariidæ the heart only is known. It is a short sac placed upon the ventral side of the stomach, between the two lobes, and having longitudinal slits in its sides. Neither Huxley nor Fol have been able to observe blood corpuscles.

In the forms in which it has been most completely made out, the circulation is as follows:—A large vessel arises from each end of the heart (fig. 13, *h.*). One of these (*br.c.*), after giving off a branch to the test (*v.t'.*), runs along the ventral edge of the branchial sac below the endostyle (*v.v.*), and gives off lateral branches which open into the transverse vessels (*tr.*) of the branchial sac, and thus distribute the blood to be aërated. The heart itself is in all probability merely the modified posterior end of this great ventral vessel. The trunk arising from the dorsal end of the heart (*c.sp.*) gives off first a branch to the test (*v.t.*), which turns towards the corresponding branch from the ventral vessel, and the two pass side by side through the mantle, to enter the test usually near the posterior end of the ventral side. In the substance of the test they break up into branches, which run alongside one another, and finally communicate in the terminal knobs (*t.k.*) of the ultimate twigs. The dorsal trunk then gives off branches to the mantle (*v.m.*), and ends by breaking up into a number of vessels for the stomach (*v.st.*), intestine, and reproductive organs.

The blood circulating in the mantle, the stomach, the intestine, and the reproductive organs is then collected by several vessels (*sp.br.*) opening into a large trunk (*d.v.*) lying along the dorsal edge of the branchial sac, and communicating with the dorsal ends of the transverse vessels of the sac. Thus, as Lacaze-Duthiers has pointed out, there are three

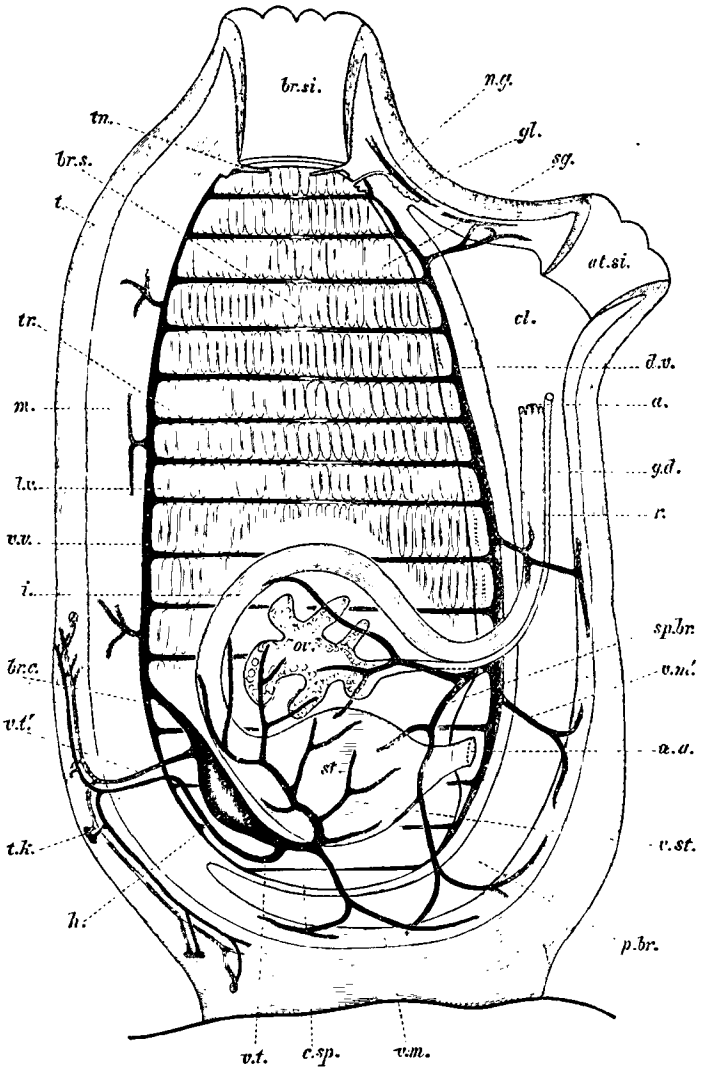


FIG. 13.—Diagrammatic longitudinal section of *Ascidia*, showing the heart, the blood-vessels, the branchial sac, the alimentary canal, &c., from the left side.

br.si., branchial siphon; *at.si.*, atrial siphon; *t.*, test; *m.*, mantle; *br.s.*, branchial sac; *p.br.*, peribranchial cavity; *cl.*, cloaca; *n.g.*, nerve ganglion; *tn.*, tentacle; *gl.*, neural gland; *æ.a.*, œsophageal aperture; *st.*, stomach; *i.*, intestine; *r.*, rectum; *a.*, anus; *ov.*, genital organs; *g.d.*, genital ducts; *h.*, heart; *c.sp.*, cardio-splanchnic vessel; *v.t.*, vessel to the test; *t.k.*, terminal knob on vessel in test; *v.t'.*, vessel from the test; *v.st.*, vessel to the stomach, &c.; *v.m.*, vessel to the mantle; *v.m'.*, vessel from the mantle; *d.v.*, dorsal vessel; *tr.*, transverse vessel of branchial sac; *l.v.*, fine longitudinal vessel of branchial sac; *sg.*, stigmata of branchial sac; *v.v.*, ventral vessel; *br.c.*, branchio-cardiac vessel; *sp.br.*, splanchno-branchial vessel.

great systems of vessels: 1st, the branchio-cardiac, bringing (when the heart is contracting from the ventral towards the dorsal end) purified blood from the branchial sac to the heart by means of the ventral vessel; 2nd, the cardio-splanchnic, conveying arterial blood from the heart to the viscera, and also to the test and mantle; and 3rd, the splanchno-branchial system, conveying the impure blood, which has been circulating in the viscera and the mantle, to the respiratory organ by means of the dorsal vessel of the branchial sac. Besides these systems, there are series of anastomotic vessels, crossing from the branchial sac to the mantle, from the mantle to the test, and from the test to the branchial sac.

When the heart contracts from the ventral to the dorsal end it is purely systemic, and contains almost pure arterial blood, the only admixture of venous being the stream returning from the test (*v.t'.*), which enters the branchio-cardiac vessel near its junction with the heart. When, on the other hand, the heart contracts from the dorsal to the ventral end, it is almost purely respiratory (not completely, as it supplies the test as well as the branchial sac), and contains impure blood returned from the viscera, the mantle, and the test. Hence the test receives a supply of pure blood from the heart only when that organ is contracting ventro-dorsally.

The blood in the Tunicata consists of a clear fluid plasma, in which float corpuscles. These are nucleated protoplasts of considerable size, and usually rounded in outline. Many are always clear and colourless, but generally a number are pigmented. The commonest colours are yellow, red, and brown, but white and blue have also been noticed.

The Reproductive Organs.

The Tunicata are hermaphrodite, though certainly in some and probably in many cases not self-fertilizing. The male and female glands are always situated together, but the closeness of their union differs in different groups. In some forms they do not attain maturity at the same time. In *Botryllus*, *Appendicularia*, &c., the ova are ripe long before the testis is fully developed.

In the Molgulidæ the ovaries and testes are united into two usually ovate, hermaphrodite genital masses, a right and a left, which are attached to the inner surface of the mantle. The right mass is placed in the centre of the right side anteriorly to the heart, and usually lies with its length placed transversely, and the genital ducts at the dorsal end. The left organ lies in the corresponding position on the left side and in front of the intestinal loop, except where the loop is so long as to make a secondary bend anteriorly, in which case the genital mass is bounded both in front and behind by the intestine.[1] In the genus *Eugyra* only this left genital gland is present.

In the Cynthiidæ we meet with a number of different arrangements. In *Culeolus* there

[1] As in *Molgula corpiformis*, see Sorby and Herdman, Journ. Linn. Soc., Zool., vol. xvi. p. 527.

are a series of quadrate genital masses (Pl. VIII. fig. 10) along each side of the body projecting into the peribranchial cavity. Each mass (Pl. VIII. fig. 11) is composed of a central testis, around which is the ovary. The testes are all connected by a conspicuous winding vas deferens, behind which is a wider oviduct.

In *Cynthia* the testes and ovaria are usually united into one or more ramified or lobed masses, which are placed between the inner surface of the mantle and the lining membrane, which is pierced by the ducts opening into the peribranchial cavity.

In *Pelonaia* there are two elongated genital masses, one upon each side and attached to the mantle. Each consists of a tubular ovary, bent in a wide loop, with the oviduct opening in front, and of a series of testicular vesicles arranged along the sides at right angles to the ovary, and having ducts which pass across it to join a central vas deferens terminating anteriorly along with the oviduct.

In *Styela* various arrangements are found;—usually one or two long sausage-like masses are formed, each of which is composed of a number of small ovaria and testes, while in the nearly allied *Polycarpa* all the small glands are distinct, so that there are a very large number of small ovaria and testes projecting from the inner surface of the mantle, and each opening separately into the peribranchial cavity. In some species a number of these small testes are arranged around each of the ovaries, and their ducts join to form a common vas deferens opening beside the short oviduct. In several genera of the Cynthiidæ there are projections from the inner surface of the mantle, sometimes pedunculated and rather like the genital glands, which have been described under the name of "endocarps." They are formed chiefly of the connective tissue of the mantle, and contain a large number of blood sinuses. Kupffer has noticed that they are especially developed in species with a powerful musculature in the mantle, and hence he considers that they are reservoirs into which the blood in the mantle sinuses may be injected when the body is forcibly contracted. Possibly, as suggested by Hancock, they serve merely as pads to keep the branchial sac and the genital glands apart.

In *Ascidia* the ovary and testis are single racemose glands lying in the fold of the intestine on the left side of the body (fig. 9, p. 40, and fig. 13, *ov.*, p. 52), and sometimes extending partly over the wall of the intestine and stomach. The ovary is usually a branched organ, the different branches uniting at a point near the centre of the intestinal loop where the oviduct commences. This duct runs along the posterior border of the intestine, and the dorsal edge of the rectum, to open into the peribranchial cavity near the anus. The testis is formed of a large number of delicate white tubules which branch dichotomously over the ovary, the stomach, and the intestine, and end in small pyriform or elongated enlargements. A vas deferens, commencing like the oviduct at the point of union of the tubules, runs alongside the oviduct during its entire course, and terminates beside it in the peribranchial cavity.

In *Clavelina* the genital glands lie in the abdomen, on the left side of the intestine,

and the ducts lead up alongside the rectum just as in *Ascidia*. The ovary shows a mass of ova of different sizes, while the testis has its ducts much branched dichotomously and ending in elongated vesicles united in pairs.

In the Ascidiæ Compositæ the position of the genital organs varies, as Milne-Edwards showed, according to the position of the heart. In *Botryllus* they are placed alongside the branchial sac. In *Didemnum* and allied forms they are, as in *Clavelina*, in the abdomen on the side of the intestine; and finally, in *Amaroucium* and a number of other genera, the genital glands, along with the heart, constitute the long post-abdomen which projects behind the loop of the intestine.

In *Pyrosoma* each ascidiozooid of the colony has a rosette-shaped testis and a female gland or "ovisac," containing a single ovum, and communicating with the atrial cavity by a short oviduct. In *Doliolum* there is a long tubular testis placed ventrally and opening into the atrial cavity. The ovary is small and lies at the posterior end of the testis. In *Salpa* only the forms united in chains develop genital organs—the solitary forms reproducing by gemmation. As in *Pyrosoma* a single ovum is formed in an ovisac united to the atrial cavity by a short oviduct. The testis is a large branched organ forming part of the visceral nucleus. Brooks considers that the *Salpæ* united in chains are the males produced by gemmation from the solitary form, which is the true female, and which has deposited an ovum in the body of each male, where it matures, becomes impregnated, and develops into a female solitary *Salpa*.

In the Appendiculariidæ the genital glands lie in the posterior part of the body, behind the intestine, and have no efferent ducts. The testis alone is generally present in this position in the adult. The ovary, which was discovered by Fol, developes later than the testis.

As this section is intended to be merely anatomical, and as the Challenger collection has thrown no direct light upon the embryology of the group, it is considered unnecessary to attempt here a brief account of the process of development in an Ascidian, the more so, as such an excellent epitome of all the best work upon this subject has been published recently in Balfour's "Comparative Embryology," vol. ii. pp. 8 to 19.

Gemmation.

Reproduction by means of more or less complicated processes of gemmation is prevalent in all groups of the Tunicata, with the exception of the Appendiculariidæ and the Ascidiæ Simplices. Among the latter it is found, however, in the family Clavelinidæ, where it results in the formation of small societies (Pl. XXXVI. fig. 2), the members of which may either remain connected by a common vascular system, or more rarely (*e.g.*, sometimes in *Clavelina*), may lose this connection and become independent.

The buds in the Tunicata are formed as outgrowths from the parent body, consisting, probably in all cases, of part of the mantle covered by the ectoderm and enclosing a diverticulum from some part of the alimentary canal. In this way portions of the hypoblast, mesoblast, and epiblast of the parent are implicated, and these layers probably give rise to the different systems of organs in the bud in much the same way as they do in the embryo.

Further details as to the process of gemmation are deferred till the second part of this Report, which will treat of the Compound and Pelagic Tunicata, among which some form of budding and metagenesis is almost universal.

DESCRIPTION OF THE SPECIES.

ASCIDIÆ SIMPLICES.

The Ascidiæ Simplices, in which I include the Clavelinidæ, may be defined as solitary or social, fixed or free, but never free-swimming, Ascidians, which may reproduce by gemmation so as to form societies of Ascidiozooids united by a common vascular system, but in which each has a distinct test, and is not imbedded along with the other Ascidiozooids in a common investing mass.

This suborder, then, includes those Ascidians which are never free-swimming and are never imbedded in a common colonial mass. They are usually solitary, and reproduce only in a sexual manner. In at least one family, however, reproduction takes place also by gemmation, which results in the formation of small colonies or "societies," but in these the different ascidiozooids are perfectly distinct, and their tests are not united into a common investing mass, as in the Ascidiæ Compositæ. They are merely joined by their posterior ends, usually by the intervention of a creeping stolon containing blood-vessels, so that the different members are connected by a colonial circulatory system.

This family, the Clavelinidæ, has usually been considered as a distinct suborder (Ascidiæ Sociales), of equal rank with, and intermediate between, the Ascidiæ Simplices and the Ascidiæ Compositæ; while it has sometimes been united with the last-named group to form the suborder Synascidiæ. I have already, in the Preliminary Report,[1] given in detail my reasons for placing the Clavelinidæ in the Ascidiæ Simplices.

The Ascidiæ Simplices may be divided into four families — the Molgulidæ, the Cynthiidæ, the Ascidiidæ, and the Clavelinidæ. In the last of these, gemmation and the formation of a colony take place; while in the others, although the apparatus for budding—the "blood-vessels" of the test—is present, and may even be developed into stolon-like processes, so far as is known buds are never formed. In this property, the power of reproducing by gemmation, the Clavelinidæ differ from the other Ascidiæ Simplices; otherwise they closely resemble the Ascidiidæ, such genera as *Ecteinascidia*, *Ciona* and *Rhopalæa* forming a passage from the one family to the other.

The Cynthiidæ and the Molgulidæ are more nearly allied to each other than to the Ascidiidæ, which family is less highly developed and less complex in organisation than the two former. The Molgulidæ are probably the most highly differentiated and most elaborately complete in all their parts, while the Clavelinidæ may be considered as the

[1] Proc. Roy. Soc. Edin., 1879–80, p. 714.

simplest and least developed forms, and through them must be traced the passage to the Ascidiæ Compositæ.

The relations between these families of Simple Ascidians may, according to our present knowledge, be expressed serially thus :—

MOLGULIDÆ—CYNTHIIDÆ—ASCIDIIDÆ—CLAVELINIDÆ.

Family MOLGULIDÆ.

Body usually free, sometimes fixed, rarely pedunculated.

Test cartilaginous, coriaceous, or membranous, often covered with sand. Branchial aperture, six-lobed; atrial aperture, four-lobed.

Branchial Sac longitudinally folded; internal longitudinal bars not papillated; stigmata more or less curved, usually arranged in spirals.

Tentacles always compound, usually much branched.

Intestine attached to the inner surface of the mantle on the left side.

Renal Sac present, upon the right side of the body.

Genitalia on the inner surface of the mantle, usually developed on both sides.

This is the highest and most complex family of the Ascidiæ Simplices. It is closely allied to the Cynthiidæ, from which it was first distinguished by Lacaze-Duthiers in 1877.[1]

Heller,[2] who had previously divided the Ascidiæ Simplices into families, arranged *Molgula* and its allies under the Cynthiidæ; there can be no doubt, however, that the two groups of genera should be considered as independent families. Lacaze-Duthiers (*loc. cit.*) discusses this question at length, and after pointing out the resemblance between *Cynthia* and *Molgula* he shows clearly the distinctions between the two forms, and establishes and defines the family Molgulidæ.

The most constant and most generally useful characteristic is, as usual, to be found in the configuration of the apertures. The branchial aperture has always six lobes, and the atrial has always four. There are several other external characters, but none are so reliable as these. The animal is usually free, or imbedded in mud or sand; sometimes, however, it is fixed like other Simple Ascidians, and a few of the newly discovered forms are pedunculated.

The outer surface of the test is usually covered by a thick coating of sand grains and shell fragments adhering to long hair-like processes of the test. Some Molgulidæ, however, have perfectly smooth tests with no adhering sand, while on the other hand some of the Cynthiidæ (*e.g.*, *Polycarpa molguloides*) exhibit the delicate hairs and thick sandy coating of a typical *Molgula*.

The branchial sac, like that of the Cynthiidæ, is longitudinally folded; here, however,

[1] Les Ascidies Simples des côtes de France, *Arch. Zool. expér.*, t. vi. p. 457.

[2] Untersuchungen über die Tunicaten des adriatischen und Mittelmeeres, Abth. iii. p. 1.

the folds are more constant in number and position. There are almost always the same number of folds on each side,[1] and that number is either five (*Molgula crystallina*, Møller), six, or seven—usually the latter. Large papillæ on the internal longitudinal bars, like those characteristic of the Ascidiidæ, are never seen. Usually the bars are perfectly smooth, but in a few species minute projections, evidently corresponding to papillæ, are present.

In a typical *Molgula* the arrangement of the stigmata is very peculiar. Each fold projecting from the inner surface of the branchial sac is formed of a longitudinal series of conical bags, having square external bases, and pointed internal apices, which may be branched. The stigmata form spiral slits more or less interrupted, extending from the base to the apex of this bag or infundibulum, as Lacaze-Duthiers names it.

The flat spaces lying between the rows of infundibula have their stigmata more irregularly arranged, but still curved, and usually having an indistinctly marked spiral disposition. In some of the new forms this typical arrangement is not found, the stigmata being irregularly disposed though still curved, but occasionally almost straight.

The tentacles are compound, and are very like those of the Cynthinæ and Bolteninæ. Lacaze-Duthiers mentions as characteristics of the Molgulid tentacles the greater number of secondary and tertiary pinnules, their more irregular size, and less tapered extremities, and most important of all the raising up of the membrane covering their inferior or branchial surface into puffed-out projections and folds.

The appearance of the intestine is rather characteristic of the Molgulidæ. It is firmly attached to the mantle on the left side, and is so sunk in it that it becomes very clearly visible from the outer surface, and seems to be in the middle of the thickness of the mantle.

The genitalia are placed on the inner surface of the mantle, and are usually developed on both sides. On the left side the gland is close to the intestine, on its anterior edge, however, not in the loop. The opposite gland, which is absent in the genus *Eugyra*, occupies the centre of the right side; while posteriorly to it lies the heart, separating the genital gland from the renal organ, which has rather a characteristic appearance in the Molgulidæ, being a compact and more or less solid organ placed near the inner surface of the mantle towards the posterior end of the right side.

The following genera have been at various times referred to this family:—*Molgula*, *Eugyra*, *Ctenicella*, *Anurella*, *Glandula*, *Gymnocystis*, *Pera*, *Lithonephrya*, *Cæsira*, and *Ascopera*. Of these *Molgula*, *Eugyra*, and *Ascopera* are represented in the Challenger collection.

Ctenicella was founded by Lacaze-Duthiers in 1877, and is probably a good genus. I have found it impossible, however, to accept his *Anurella*. It is distinguished from all other Molgulidæ by the remarkable structure of the larva, which is "amœboid" and

[1] In *Molgula pyriformis* (see page 79) there are seven folds on the right side and six on the left. It is possible, however, that this may be an individual peculiarity.

tail-less.[1] This most interesting developmental difference does not seem to be accompanied by any structural peculiarities in the adult form, which apparently does not differ generically from *Molgula*.

Glandula, as I pointed out in the Preliminary Report,[2] does not belong to the Molgulidæ, but should be placed in the sub-family Styelinæ of the Cynthiidæ.

Gymnocystis was founded by Giard in 1872[3] for van Beneden's *Ascidia ampulloides*, which has been so often described, and referred to so many different genera. This species is undoubtedly one of the Molgulidæ, but I see no reason for separating it from *Molgula*. Giard distinguishes it chiefly on account of the test, which is smooth and semi-cartilaginous, like that of some species of *Ascidia*. This kind of test is, however, found in several undoubted species of *Molgula* (*e.g.*, *Molgula gregaria*, Lesson), and graduates into the condition characteristic of the genus. I agree, therefore, with Lacaze-Duthiers in referring van Beneden's *Ascidia ampulloides* to the genus *Molgula*.

Pera, Stimpson, is probably either a *Molgula* or an *Eugyra*. Nothing in the description warrants our considering it as the type of a new genus. The species described by Macdonald,[4] from the Bellona reefs, under the name of *Pera huxleyi* seems to be a *Rhodosoma*, and in that case belongs to the Ascidiidæ.

Lithonephrya is characterised by Giard[5] as having the renal organ occupied by a large brown concretion. Otherwise it seems identical with *Molgula*.

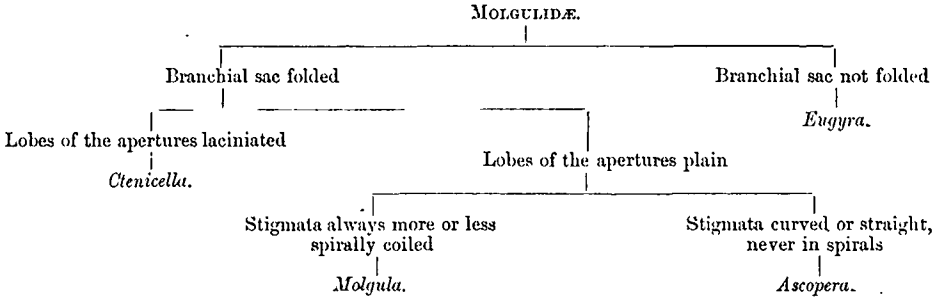
Under the names of *Cæsira parasitica*, *Cæsira ficus*, and *Cæsira pellucida*, Macdonald[6] described in 1859 three species of Simple Ascidians from Australia. They are evidently Molgulidæ, but whether or not they differ generically from *Molgula* and *Eugyra* is very doubtful. The tribe Cynthiæ Cæsiræ of Savigny includes the single species *Cynthia dione*, which seems from the figures and description,[7] notwithstanding the assertion that both apertures are four-lobed, to belong to the Molgulidæ, and probably to the genus *Molgula*. Heller[8] states that its nearest ally is Stimpson's *Glandula*. I cannot endorse this, as the latter genus is closely allied to *Styela*, while I consider Savigny's *Cynthia dione* a species of *Molgula*.

Ascopera was founded[9] for the reception of two very large new species from the Antarctic. They are attached, pedunculated, and not incrusted; the chief peculiarity, however, is in the branchial sac, as the stigmata are never arranged in spirals, no infundibula being present.

[1] See Lacaze-Duthiers, Asc. Simp. des côtes de France.
[2] Proc. Roy. Soc. Edin., 1880-81, p. 234.
[3] Archives de Zoologie expérimentale et générale, t. i. p. 405.
[4] J. D. Macdonald, Jour. Proc. Linn. Soc., 1862.
[5] Arch. de Zool. expér., t. i. p. 404.
[6] J. D. Macdonald, Trans. Linn. Soc., vol. xxii. p. 367.
[7] Mém. sur les Anim. sans Vert., p. 153, pl. vii. fig. 1.
[8] Untersuch. ü. d. Tun. d. adriat. u. Mittelmeer., Abth. iii. p. 2.
[9] Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 238.

Eugyra differs from *Molgula* chiefly in having no true folds in the branchial sac, and in having only a single genital gland, placed beside the intestine on the left side of the body.

The following shows the genera of the family in a tabular form :—



Ascopera, Herdman.

Ascopera, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 238.

Body more or less pyriform, pedunculated, attached.

Test thin, between membranous and leathery in texture, having no adhering sand and no hair-like processes.

Branchial Sac with seven folds on each side. Stigmata straight or curved, but not arranged in spirals.

Tentacles compound.

Genitalia developed on both sides. The gland on the left side lies ventrally to the rectum.

This genus is closely allied to *Molgula*, and has the chief characters of the family very well marked. The branchial aperture is six-lobed, and the atrial four-lobed; the branchial sac has seven longitudinal folds on each side; the tentacles are compound, and a distinct renal organ is present, lying on the right side posteriorly to the genital gland. The external appearance, however, is not suggestive of a *Molgula*. The body is pedunculated, and was evidently attached by the posterior end of the short stalk while the outer surface of the test is not incrusted with sand and bears no hair-like processes.

The arrangement of the stigmata in the branchial sac differs considerably in the two species, but in neither are they disposed in spirals, as no true infundibula are present.

The intestine lies upon the left side of the branchial sac and runs antero-posteriorly; it has a large genital gland at its ventral edge, while the other genital gland is situated in the centre of the right side, projecting from the inner surface of the mantle.

There are two species in the genus, *Ascopera gigantea* with a large body and a short peduncle, and *Ascopera pedunculata* with a small body and a much longer peduncle.

Ascopera gigantea, Herdman (Pl. I., Pl. II. figs. 1–4, and Pl. III. figs. 3–5).

Ascopera gigantea, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 238.

External Appearance.—The shape is somewhat pyriform, and not compressed laterally. The anterior end is wide, truncated, slightly cleft in the centre, and ends in a siphon at each extremity. Behind the siphons the body swells out into a globular form, attaining its greatest width at about two-fifths of its length from the anterior extremity; it then narrows to become the wide peduncle constituted by the posterior two-fifths. The edges are both convex, but the dorsal is more so than the ventral, especially towards its posterior end. The animal is attached by the lower (posterior) end of the stalk.

The apertures are both at the anterior end; they are distant, conspicuous, tubular, and prominent. The branchial is at the end of a projection from the ventral edge of the anterior end, in the form of a wide tube bent round posteriorly so as to present a convex surface anteriorly and an open mouth posteriorly. The aperture is large and funnel-shaped, and is bounded by six wide, low, undulated lobes separated by slight clefts. The atrial aperture is placed at the summit of a projection from the dorsal edge of the anterior end. This projection is larger than that on which the branchial aperture is placed, and extends further forwards, thus rendering the atrial aperture more anterior than the branchial. The aperture is wide, quadrangular, and directed anteriorly. It is bounded by four lips with slightly undulated edges.

The surface of the body is even, there being no projections or marked irregularities. It is not, however, perfectly smooth, being finely roughened all over.

The colour is a pale yellowish grey-green, with a slight tinge of brown towards the lower end of the peduncle.

Entire length (antero-posterior), 30 cm.; length of peduncle, 10 cm.; greatest breadth (across apertures), 15 cm.; breadth in middle of body (dorso-ventral), 12 cm.

The Test is thin and almost membranous, but tough. It is semi-transparent, and is slightly roughened externally, but quite smooth on the inner surface.

The Mantle is delicate and membranous, with a few distant rather strong muscle bands running transversely over about the anterior half of the right side and the left side; they are only absent on the dorsal part of the left side and the posterior end. At the posterior end of the body, where the peduncle commences, the mantle is firmly united to the test, even after immersion in alcohol.

The Branchial Sac is extremely thin and delicate, and has seven folds on each side; those next the endostyle are rather slighter than the others. The internal longitudinal bars are wide but delicate. The transverse vessels are also wide, and all of one size. The

internal longitudinal bars and transverse vessels give off trunks which branch and anastomose, forming an irregular but close network, the meshes of which are the stigmata.

The Dorsal Lamina is a plain membrane, short, 4 mm. wide, and rather thick. There are no ribs nor teeth.

The Tentacles are compound and large. There are eight larger and eight smaller placed alternately, and about sixteen very minute ones intermediate to the others.

The Dorsal Tubercle is large and prominent. Both horns are much coiled, forming conspicuous spirals.

The Alimentary Canal is placed on the left side of the branchial sac, lying antero-posteriorly. The œsophagus is short and narrow; the stomach is small and pyriform; the first part of the intestine is large, and turns round posteriorly to form a narrow loop; the rectum runs parallel to the intestine and stomach, and is very narrow.

Genitalia are developed on both sides. The gland on the left side is sausage-shaped, and lies parallel to the rectum on its ventral edge. The gland on the right side is similar in shape, and is placed in front of the curved renal sac.

This is the largest Simple Ascidian with which I am acquainted. The figure (Pl. I. fig. 1) is only about three-quarters of the natural size, but otherwise it gives a very good idea of this singular animal. The most notable points in the external configuration are the globular central part of the body, the narrow posterior part forming the peduncle, the wide anterior end, and the two apertures—the atrial, the more anterior of the two, and the posteriorly directed funnel-like branchial. Both are very wide, and it seems almost impossible that the animal should ever be able to close them completely.

The test is remarkably thin and membranous for an Ascidian of such a size. It is, however, very tough. It thickens towards the edges of the apertures and on the peduncle while the thinnest region is in the centre of the right and left sides. It is very finely roughened all over, so as to have a minutely granular texture, while at the posterior end there are a few slight processes for attachment to stones (Pl. I. fig. 1).

Thin sections show that the matrix is homogeneous, and contains large numbers of very small bladder-cells often aggregated in heaps (Pl. II. fig. 4 *bl.*), and minute globular, fusiform, and stellate nucleated protoplasts (*t.c.*).

The mantle is also very delicate, and the musculature is feeble. None of the short-bellied muscles so characteristic of the mantle in the typical Molgulidæ are found. Sphincter muscles are present, but they are not of great strength (Pl. I. fig. 1, atrial aperture).

The branchial sac is most remarkable, and is much the most delicate form known. Its tenuity is such between the folds, that when raised on a fine paint brush it seems like a sheet of mucus, and scarcely holds together. It is perfectly transparent, and requires to be stained before the structure can be made out. Pl. III. fig. 3, represents a small

portion of the sac slightly enlarged, and shows the wide, but very thin transverse vessels (*tr.*), and internal longitudinal bars (*i.l.*). One of the longitudinal folds is here seen (*br.f.*), and it shows nine internal longitudinal bars, four on each side and one at the edge. It is obvious from the figure how the space between two adjacent bars decreases as you work along the fold from the large mesh (*mh.*) of the space between the folds to the free edge of the fold. Pl. II. fig. 1, represents a portion of the branchial sac more magnified to show the complicated branching and anastomosing of the vessels, and the way in which the stigmata lie in different planes, there being in some places as many as three systems of vessels crossing one behind the other. A small part is shown very highly magnified in Pl. II. fig. 2, to exhibit the stigmatic ciliated cells; over the greater part of the vessels of the sac the cilia have been lost. Figure 3 shows a small part of the surface of a vessel still more highly magnified; the epithelium is squamous, and the cells are large, delicate, and distinctly nucleated. Pl. III. fig. 4, shows a part of the branchial sac where the stigmata are much more regular, the smaller vessels being less curved. This is distinctly an approach to the arrangement of the stigmata in *Ascopera pedunculata*.

The dorsal lamina (Pl. III. fig. 5, and Pl. I. fig. 2, *d.l.*), is wide, but short. There are eight large and strong tentacles (Pl. III. fig. 5), and the same number of much smaller ones, while, alternating with these sixteen, there are about the same number of very minute but still compound ones. The dorsal tubercle (Pl. III. fig. 5, *d.t.*), is large, and much coiled. There is no distinct peritubercular area.

The œsophageal aperture (Pl. I. fig. 2) is situated far forward in the branchial sac, and is ear-shaped, with a double lip on the right side. It lies on a flat triangular area at the posterior extremity of the dorsal lamina, at the point of convergence of the fourteen branchial folds (see Pl. I. fig. 2, 1–7). The œsophagus (Pl. I. fig. 3, *œ.*) is short, cylindrical, and rather narrow. It runs directly posteriorly, and opens suddenly into the wider end of the small pyriform stomach (*st.*). At the posterior narrower end of the stomach the wide intestine commences. The wall of the stomach is thick, and its outer surface is rough from the presence of a number of small rounded projections. This structure is continued on to the first portion of the intestine, but soon dies away; and the rest of the tube has a thin membranous wall through which the coiled fæcal masses are distinctly seen. The wide intestine runs directly posteriorly from the stomach for a considerable distance (*i.*), then turns round ventrally, and, after running for a short distance anteriorly, turns at right angles dorsally, so as to come in contact with the first part of the intestine. Here the tube, which may now be called the rectum (*r.*), becomes very narrow, and during the remainder of its course lies in close contact with the first part of the intestine, the stomach, and finally the œsophagus.

Along the ventral edge of the rectum lies the large, yellow, sausage-like, genital gland (Pl. I. fig. 3, *g.*) with its axis directed antero-posteriorly. The duct is of moderate length (*g.d.*) and projects from the anterior end, opening into the peribranchial cavity,

but at a considerable distance from the atrial aperture. The gland on the right side is similar in size and shape. It is 4·5 cm. in length (antero-posteriorly) and 1·5 cm. in breadth, while the membranous duct extends from the anterior end for a distance of 1·3 cm.

One large specimen of this species was obtained to the south of Kerguelen Island, at Station 150, February 2nd, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bot. temp., 1°·8 C.; hard ground.

Ascopera pedunculata, Herdman (Pl. II. fig. 5, Pl. III. figs. 1 and 2).

Ascopera pedunculata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 239.

External Appearance.—This species is club-shaped, and consists of an ovate or roughly diamond-shaped body, somewhat compressed laterally, and borne on the summit of a thick peduncle. The anterior end is straight, wide, and truncated, and is continued at its extremities into the branchial and atrial siphons. The dorsal and ventral edges are nearly straight, and slope outwards and backwards to the wide posterior end. Both are slightly convex, and the dorsal is the shorter and more curved of the two, while the ventral is straighter and longer. The posterior end is wide, straight, and obliquely truncated, sloping backwards and ventrally. It joins the dorsal edge by a continuous gentle curve, and at its ventral edge is prolonged into the large peduncle, which is twice as long as the body, but thin, being compressed laterally. It is narrow where it joins the posterior end of the body, but increases gradually in breadth as it proceeds backwards, till at the posterior end, where it is attached to the bottom, it is more than twice as broad as at the anterior end.

The apertures are at the extremities of the anterior end, moderately distant, conspicuous, slightly projecting, and distinctly lobed. The branchial is at the ventral edge of the anterior end, and has its six-lobed siphon bent so that the opening looks directly ventrally. The atrial is at the dorsal edge, is four-lobed, and has the siphon not so prominent as that of the branchial, and not bent, the aperture being directed dorsally and slightly anteriorly.

The surface is even, there being no marked irregularities. The body, however, is slightly and regularly roughened all over, so as to have a granular appearance. The stalk is smooth. The colour is pale grey.

Length of body (antero-posterior), 7 cm.; breadth of body (dorso-ventral), 7 cm.; length of peduncle, 17 cm.; breadth of peduncle, 4·6 cm.

The Test is somewhat leathery; it is moderately thick and tough on the body, but very thin and membranous on the peduncle. It is almost opaque on the body, but transparent on the peduncle. It is smooth on the inner surface.

The Mantle is thin and membranous, or in parts semi-gelatinous. The posterior part is prolonged for 13 cm. into the peduncle. The musculature is feeble.

The Branchial Sac is delicate, and has seven folds on each side. The internal longitu-

dinal bars are wide, but delicate, and not distant. The transverse vessels are rather irregular, and there are generally several smaller vessels of different sizes placed between each pair of larger ones. Frequently the smaller vessels do not extend the entire breadth of the mesh. The meshes are somewhat variable. Considered as extending from one larger transverse vessel to the next, they are generally elongated antero-posteriorly, but may be square or even elongated transversely. The stigmata are of different lengths, and often run across (behind) the transverse vessels; they are generally straight and all placed longitudinally.

The Dorsal Lamina is broad but thin and short; it is quite plain, with no ribs nor teeth.

The Tentacles are compound and large, sixteen in number, and of two sizes placed alternately.

The Dorsal Tubercle is prominent, elongated transversely, and having the aperture at the right side. The horns are large, and both coiled outwards.

The Alimentary Canal, as in the preceding species, is on the left side of the branchial sac, lying antero-posteriorly, and chiefly along the dorsal edge and the dorsal part of the posterior end.

Genitalia are present on both sides of the body. The gland on the left side lies ventrally to the intestine, while the other genital gland occupies the centre of the right side.

This species, though agreeing with *Ascopera gigantea* in all important characters, has a very different appearance (Pl. III. fig. 1). The proportion between body and peduncle is the reverse of that which obtains in the last species, the peduncle being here twice as long as the body. The body is somewhat similar in appearance, though much smaller and more compressed laterally. The apertures are placed at the extremities of the anterior end, but the atrial is turned up so as to be directly opposed to the peduncle which arises from the ventral edge of the posterior end. Hence there is a liability to consider the atrial aperture as forming the anterior extremity, and the peduncle the posterior, and one is greatly tempted to describe the animal in this position. It would, however, be distinctly an error, as the morphological anterior end is always indicated by the branchial aperture, and the dorsal edge is that side on which the nerve-ganglion (or, for convenience in practice, the atrial aperture) is placed. In the present case it would make an immense difference and cause utter confusion to follow what seems the natural enough course of considering the two opposite ends of the animal as anterior and posterior (in place of calling the one the dorsal edge of the anterior end and the other the ventral edge of the posterior end), as what is really the ventral edge, that on the extremity of which the branchial aperture is placed (Pl. III. fig. 1), would then become the dorsal, and the right and left sides of the animal would also be transposed. This explains the apparent abnormality of the principal viscera being placed on what seems the right side.

The test over the surface of the body is rather stronger than that of *Ascopera gigantea*, but in the peduncle, on the other hand, it is much thinner.

The mantle is thin, and towards the posterior end becomes semi-gelatinous, and forms a solid tail-like body, which projects for a considerable distance into the large hollow of the peduncle. In the spirit specimen this "tail" was much contracted, and did not nearly fill up the hollow, with the walls of which it had no connection at any point. In minute structure it is not unlike the test, but is covered externally by a complete layer of squamous epithelium (the ectoderm) formed of diamond-shaped or short fusiform cells. There is a homogeneous matrix containing numerous rounded, fusiform, irregular, and stellate protoplasts, often crowded together. Here and there sinuses containing blood-corpuscles are met with.

The branchial sac (Pl. II. fig. 5) seems at first sight very different from that of *Ascopera gigantea*, but a comparison with the part of the latter represented on Pl. III. fig. 4, shows that the two are not so very different after all, although the arrangement in the present species is much more regular, and the stigmata are less curved, and run longitudinally, thus causing the sac to have rather a Cynthiad appearance. Molgulid characteristics are seen, however, in the irregularity in the length of the stigmata, in the way in which they cross behind the transverse vessels, thus appearing to break up the latter, and in the occasional presence of very delicate short transverse bars crossing the stigmata between the adjacent fine longitudinal vessels (Pl. II. fig. 5).

The dorsal tubercle has rather a remarkable appearance (Pl. III. fig. 2), being placed transversely, and elongated, so that its hollow is deep and narrow, while the horns are large, turned outwards (one anterior, and one posterior), and equally coiled.

The œsophageal aperture is situated far forward in the branchial sac, not far from the atrial aperture. The intestine, as in *Ascopera gigantea*, forms a long narrow loop, the rectum being parallel to the first part of the intestine.

The genital gland on the left side lies on the ventral edge of the rectum, and is large, of a bright yellow colour, and more irregular in shape than that of *Ascopera gigantea*.

The gland on the right side lies near the ventral edge, is large, and elongated antero-posteriorly. Behind it is situated the crescentic thin-walled renal sac.

One specimen was obtained in the same locality at which *Ascopera gigantea* was found, to the south of Kerguelen Island, at Station 150, February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bot. temp., 1°·8 C.; hard ground.

Molgula, Forbes.

Ascidia, Müller, Zool. Dan., vol. iv. 1806. In part.
Molgula, Forbes, History of British Mollusca, vol. i. p. 36. 1853. In part.
Molgula, Kupffer, Jahresber. der Commiss., &c., p. 223. 1875. In part.
Molgula, Heller, Untersuch. ü. d. Tun. d. Adriat. Meer., Abth. iii. p. 27. 1877.
Molgula and *Anurella*, Lacaze-Duthiers, Asc. Simp. des côtes de France, p. 568.
Molgula, Traustedt, Oversigt over de fra Danmark og dets nordlige Bilande kjendte Ascidiæ Simplices. Vidensk. Medd. Nat. Foren. i Kjøbenhavn, 1879–80, p. 421. 1880.

Body usually globular, attached or free, often incrusted with sand. Branchial aperture six-lobed, atrial four-lobed.

Test usually thin but tough, often having hairs on the outer surface.

Mantle thin and membranous; musculature usually feeble; consisting chiefly of long radiating bundles arising from the sphincters, and of short fusiform clumps of fibres scattered through the mantle.

Branchial Sac folded longitudinally; stigmata more or less curved, coiled spirally in infundibula.

Tentacles compound.

Alimentary Canal on the left side of the branchial sac.

Genitalia developed on both sides.

Renal Organ in the form of a crescentic sac placed in the centre of the right side of the mantle, and usually containing concretions.

This genus has been so fully discussed recently by Lacaze-Duthiers in his great monograph on the Molgulidæ[1] that it seems superfluous to give a detailed account here of the general characters. A few special points, however, require to be mentioned. As is stated above, I have found it impossible in dealing with this collection to recognise Lacaze-Duthiers' genus *Anurella*, on account of the absence in the adult animal of any characters distinguishing it from *Molgula*.

None of the distinguishing features of the genus *Molgula* can be derived from the external appearance. Most of the species are globular and unattached, but on the other hand some are elongated, and some quite irregular in shape; some are attached, and some are even shortly pedunculated. The condition of the test also furnishes no criterion. Typically it is thin and membranous, but covered with sand-grains attached to long hair-like processes. *Molgula gigantea* has its posterior half in this condition, but the anterior part is perfectly smooth and has no incrusting sand, while *Molgula pyriformis* is perfectly free on the entire surface both from adhering sand and hairs.

The musculature of the mantle is characteristic for many of the species, but does not hold for all. It is feebly developed on the whole, leaving the mantle transparent (Pl. V. fig. 9), and consists chiefly of (1), the sphincters round the apertures, which are clearly defined and of moderate strength; (2), a series of longitudinal bundles, which radiate from the lower edge of each of the sphincters, and gradually die away as they recede from the apertures; and (3), of bundles of fibres scattered over the general surface of the mantle. These last are partly the ordinary narrow greatly elongated bands found in other groups, but they are chiefly a characteristic form found only in the Molgulidæ, namely short fusiform clumps consisting of from two to a dozen, but generally four to six, thick short fibres closely united and tapering rapidly towards both ends so as to form a

[1] Les Ascidies Simples des côtes de France.

spindle-shaped bundle. These fibres are usually of a clear yellow colour, and at the ends they become continuous with a very long delicate transparent fibre, which runs usually for a great distance through the mantle, and may either die away or may join a similar filament from another bundle. The whole arrangement is rather suggestive of a muscle with a belly and two long tendons as seen in higher vertebrates.

The chief features in the branchial sac of *Molgula* are the distinct folds and the more or less curved stigmata arranged in infundibula.

The alimentary canal is always situated on the left side of the branchial sac, and has one of the genital glands in its neighbourhood, the other being placed near the centre of the opposite side of the mantle, and always anterior to the sac-like renal organ (Pl. IV. fig. 7).

The Challenger collection contains six species of this genus, four of which were new to science.

Molgula gigantea, Cunningham (sp.) (Pl. IV. figs. 1–4).

Cynthia gigantea, R. O. Cunningham, The Nat. Hist. of the Straits of Magellan, Edin. 1871.
Cynthia gigantea, R. O. Cunningham, Notes on the Reptiles, &c., obtained during the voyage of H.M.S. "Nassau," Trans. Linn. Soc., vol. xxvii. p. 489.
Molgula gigantea, Herdman, Preliminary Report, part iv., Proc. Roy. Soc. Edin., 1880–81, p. 234.

External Appearance.—The body is oblong or oblong-ovate in shape, often cylindrical, and usually compressed laterally. The anterior end is usually narrowish, but truncated and flat. The posterior is rounded, usually broader than the anterior, and sometimes irregular; the dorsal and ventral edges are gently convex, and about equal in length.

The apertures are both at the anterior end; they are moderately distant, conspicuous, and slightly projecting. The branchial is at the ventral edge of the anterior end, on a distinctly six-lobed teat-like projection, and usually bent so that the aperture points ventrally and somewhat posteriorly. The atrial is at the dorsal edge of the anterior end; it is not so prominent as the branchial, is four-lobed, and directed more or less anteriorly.

The surface is even and moderately smooth in the upper part. The lower half is thickly incrusted with sand attached to fine hair-like processes of the test.

The colour in the upper part is usually a pale slate-blue.

Length of body (antero-posterior) in a specimen of medium size, 19 cm.; breadth of body (dorso-ventral), 10·5 cm.; thickness of body (lateral), 7·5 cm.

The Test is coriaceous, and rather thin but tough; it is opaque, and smooth in the upper (anterior) part, but bears hairs on the posterior part, to which sand grains are attached, forming an incrusting coat.

The Mantle is thick; and the musculature is strong, especially along the dorsal and ventral edges.

The Branchial Sac is very thick and strong, with seven large folds on each side. The transverse vessels are very large, few, and visible to the eye. They give off numerous branches, which divide and anastomose, forming a network of wide vessels which form the meshes of the sac. These vessels give off much smaller tubes which bound the stigmata. The stigmata are numerous, irregular, and arranged in spirals forming infundibula.

The Dorsal Lamina is a short but very broad membrane, with no ribs, but having an irregular margin.

The Tentacles are compound, and large; they are sixteen in number, and of two sizes, placed larger and smaller alternately.

The Dorsal Tubercle is large and prominent, with both horns much coiled spirally.

This large species was obtained by Professor R. O. Cunningham in the Straits of Magellan during the cruise of the "Nassau," and was briefly described under the name of *Cynthia gigantea* in the Transactions of the Linnæan Society of London for 1871.

Cunningham's description merely refers to a few features in the external appearance, and is insufficient for the identification of the species. It was only when examining the "Nassau" collection in the British Museum that I discovered that the large Challenger *Molgula* from the Straits of Magellan was identical with Cunningham's *Cynthia gigantea*, which had been referred to the wrong genus and family; consequently, while retaining the old specific name, I have treated it otherwise as a new species, and have figured and described it anew in detail.

The external form is somewhat variable; some specimens are almost globular, and others fusiform, while all intermediate shapes occur. The specimen figured (Pl. IV. fig. 1) is typical as to shape, but is of small size. Cunningham mentions that the largest specimen obtained by the "Nassau" measured "eight inches from base to apertures, and was between four and five inches broad." Many of the Challenger specimens exceed those dimensions, the largest being 33 cm. in length, and 17·5 cm. in breadth. This is the next largest Simple Ascidian to *Ascopera gigantea*.

The following list shows the proportions between length and breadth in thirty of the Challenger specimens:—

Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).	Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).
1	5·5 cm.	4 cm.	10	10 cm.	6 cm.
2	6 „	5 „	11	10 „	7 „
3	6·5 „	4 „	12	13 „	9 „
4	7 „	4 „	13	13·5 „	9 „
5	7 „	4·5 „	14	14 „	8 „
6	7 „	6 „	15	15 „	7 „
7	8 „	4 „	16	16 „	10 „
8	9·5 „	5·5 „	17	18 „	9 „
9	10 „	5 „	18	18·5 „	10 „

Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).	Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).
19	19 cm.	10·5 cm.	25	25 cm.	11 cm.
20	19 „	13 „	26	26 „	13 „
21	20 „	9 „	27	26 „	15 „
22	20 „	10 „	28	29 „	14 „
23	21 „	12 „	29	30 „	16 „
24	24 „	15 „	30	33 „	17·5 „

The test is leathery in texture and is rather thin (varying from ·3 to 3 mm.) but very tough. It is quite opaque. In the upper (anterior) part, in young specimens, it is smooth and shining, while in older ones it is wrinkled and somewhat irregular and rough. A large part of the posterior end, varying from one-third to two-thirds (and even in some specimens to three-quarters on the left side, which is always more incrusted than the right) of the total length, bears numerous long delicate hairs to which sand is attached (Pl. IV. fig. 1) in such quantity as to form towards the posterior end a solid coating often 6 mm. in thickness. As Cunningham observed there are frequently quantities of Hydroids, Polyzoa, and Compound Ascidians attached to the outer surface of the test.

It varies greatly in colour. In young specimens it is a pale greyish blue or slate colour, and is smooth and shining; while in older specimens, where it is rough and irregular, the colour is much darker, and varies from a dirty blue to brown.

In minute structure the test is composed of a translucent matrix in some places homogeneous, but generally slightly fibrillated, especially near the inner surface where the fibres are distinct and run parallel to the surface. In this matrix lie minute rounded protoplasts and a few larger bladder-cells, and towards the outer surface numbers of yellow and brown pigment cells, forming a distinct dark-coloured zone. Vessels are present here and there, but are evidently feebly developed. The inner surface is lined by a layer of columnar epithelium (the ectoderm).

The mantle is rather thick, except on the centre of the right and left sides where it becomes membranous. The muscle bands are yellow, and are numerous and stout. They are especially developed on the branchial and atrial siphons, forming powerful sphincters, over the anterior end, down the dorsal and ventral edges, and round the posterior end.

The branchial sac (Pl. IV. figs. 2 4) is very thick and solid looking, and the folds, which converge towards the œsophageal aperture, are well marked. Those on the right side have their œsophageal ends attached to the dorsal continuation of the endostyle (Pl. IV. fig. 4), while those on the left side join the posterior extremity of the dorsal lamina.

There are only six to ten large transverse vessels and they run obliquely, converging towards the short dorsal lamina (Pl. IV. fig. 2, *tr.*). The infundibula (Pl. IV. fig. 3) are numerous, irregular, and shallow, and the stigmata vary greatly in length.

The endostyle is conspicuous and is very long, being continued round the posterior end of the branchial sac and up the dorsal edge as far as the œsophageal aperture.

The dorsal lamina (Pl. IV. fig. 4, *d.l.*) is short and broad; the free edge is crenated, but a regular series of teeth is not present.

The tentacles are large and greatly branched, and their branchial surface, from which the pinnæ spring, is usually vesicular. The shape of one of the larger tentacles is irregularly pyramidal with the apex generally curled upwards towards the branchial aperture, so that the lower side on which the branches are placed is convex (Pl. IV. fig. 4, *tn.*) The base is very thick, and is seen from sections to be highly muscular. Numerous bundles of fibres, imbedded in the connective tissue and running in all directions and interlacing, occupy a zone extending about half-way to the centre of the tentacle.

The peritubercular area is very small, and the dorsal tubercle extends across the præbranchial zone almost to the base of the tentacles (Pl. IV. fig. 4).

The intestine is large and lies on the left side, occupying chiefly the dorsal edge and posterior end. The œsophageal aperture (Pl. IV. fig. 4, *œ.a.*) is situated far forward in the sac, generally between one-third and one-fourth of the distance from the anterior to the posterior end. In a specimen 16 cm. in length and 7·5 cm. in breadth, the dimensions of the branchial sac were as follows:—

From peripharyngeal band to posterior end, . . .	8 cm.
From peripharyngeal band to œsophageal aperture, . . .	2 „
From peripharyngeal band to branchial aperture, . . .	4 „
Breadth of sac at level of œsophageal aperture, . . .	4 „
Breadth of sac at broadest part, ...	6 „

The œsophagus is short and wide, and runs directly posteriorly from the œsophageal aperture to open into the large stomach lying on the left dorsal edge of the posterior part of the branchial sac. The intestine issuing from the stomach soon reaches the posterior end of the branchial sac, and after turning towards the ventral edge runs anteriorly for a short distance, then curving dorsally and posteriorly it returns closely pressed against its first part, so that no open loop is formed, and finally runs anteriorly along the dorsal edge of the branchial sac, past the œsophageal aperture, and opens into the relatively small cloacal part of the peribranchial cavity.

There are two ovate genital glands imbedded in the mantle, one on each side. That on the left side lies anteriorly to the intestine, and nearer the ventral than the dorsal edge. The gland on the right side is nearly in the centre, and lies anteriorly and ventrally to the large curved renal sac.

This species was obtained by the "Nassau" at two localities—Gregory Bay and near Cape Virgins. In the Liverpool Free Public Museum[1] there are some small specimens, which were dredged by Captain W. H. Cawne Warren, off the Patagonian Bank, lat. 41° 30′ S., long. 52° 0′ W.; depth, 50 fathoms.

The Challenger specimens (nearly forty) were all dredged at Station 313, January

[1] I am much indebted to Mr. T. J. Moore, the curator of this excellent museum, for his kindness in allowing me to examine specimens of this and several other species of Ascidians in the collection under his care.

20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; depth, 55 fathoms; bottom temperature, 8°·8 C.; sandy bottom.

Molgula gregaria, Lesson (sp.) (Pl. IV. figs. 5–8).

Cynthia gregaria, Lesson, Centurie Zoologique, p. 157, pl. 52, fig. 3. Paris, 1830.
Cynthia gregaria, R. O. Cunningham, Notes on the Reptiles, &c., obtained during the voyage of H.M.S. "Nassau," Trans. Linn. Soc., vol. xxvii. p. 488.
Molgula gregaria, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 234.

External Appearance.—The body is almost spherical or sometimes ovate, and is slightly compressed laterally. The posterior end is large and rounded; the anterior is somewhat narrower and slightly projecting. The dorsal and ventral edges are strongly and equally convex. It is attached by the posterior end of the left side.

The apertures are both at the anterior end, and are not distant; the branchial is low, hemispherical, and six-lobed; the atrial is more prominent, narrower, and four-lobed. The surface is smooth and glistening, slightly undulating and furrowed, and occasionally a little wrinkled. The colour is white, with usually a hyaline blue tinge.

Length of the body, 7 cm.; breadth of the body, 8 cm.

The Test is cartilaginous and solid; it is moderately thick and strong, and almost opaque; no vessels are visible.

The Mantle is thick, but not very muscular.

The Branchial Sac is strong, with seven distinct but narrow folds on each side. The internal longitudinal bars are strong but few. The transverse vessels are very irregular; they divide and anastomose to form a network in the meshes of which the irregular and complicated infundibula are set. The stigmata are rather small, and they are curved and arranged in spirals. Broad horizontal membranes attached to the internal longitudinal bars run along the chief transverse vessels.

The Dorsal Lamina is rather thin, but broad; it is crumpled, but neither ribbed nor toothed.

The Tentacles are large and much branched; they are fourteen in number, and of two sizes, placed large and small alternately.

The Dorsal Tubercle is elliptical or kidney-shaped; both horns are much coiled, and form large spirals; the aperture is at the right side.

This species, like the last, was first described as a *Cynthia*. As no account of it has ever been published except as to the external appearance, I have given here a full description and figures.

The specimens differ somewhat in appearance on account of the condition of the test. This seems to vary considerably, being in some individuals thin, except at the posterior end, while in others it is much thicker, stiffer, and more opaque (as in the specimen figured, Pl. IV. fig. 5). The lobes around the prominent apertures are very distinct, and the branchial has, in addition to the six ordinary lobes, a series of six much

smaller placed alternately with the larger ones (Pl. IV. fig. 5). In minute structure, the test is very compact (Pl. IV. fig. 8), having a close homogeneous matrix (*t.m.*), in which large fusiform and stellate distinctly nucleated protoplasts (*t.c.*) are scattered. In the protoplasm of some of these, clear spaces or vacuoles are visible, and these seem in process of becoming converted into bladder-cells, but no true bladder-cells and no pigment-corpuscles were noticed.

The mantle is thick and dark coloured, but is not very muscular, the chief fibres being a series of bands radiating from each aperture (Pl. IV. fig. 7, *m.b.*), and the sphincters. There are also much finer irregular bundles of fibres all through the mantle.

The branchial sac is peculiarly thick and opaque (Pl. IV. fig. 6). The network formed by the transverse vessels is strong, and there are broad horizontal membranes hanging from most of the transverse vessels and attached by their ends to the internal longitudinal bars. The stigmata are small, as the interstigmatic tubes, like all the vessels in this sac, are strong.

The dorsal tubercle is enclosed in a triangular peritubercular area, and has a reniform shape with the greatest length antero-posterior. Both horns are coiled inwards and form close spirals, the posterior being the larger.

The œsophageal aperture is a little more than one-third of the way down, and the œsophagus curves ventrally and posteriorly. The stomach is not clearly defined, and the intestine turns anteriorly and then dorsally for a short distance, then curves abruptly on itself and returns on the anterior side of the former part, and, closely pressed to it, passes the œsophagus and ends near the atrial aperture. The genital gland on the left side lies in front of the intestine on the ventral side of the rectum. The gland on the left side (Pl. IV. fig. 7, *g.*) lies near the dorsal margin in front of the large crescentic renal sac (Pl. IV. fig. 7, *r.o.*), which contains, occupying its centre, a large pulpy elongated mass full of black concretions.

Lesson's specimens were got at Port Louis, Falkland Islands. Cunningham obtained his at Gregory Bay, in the Straits of Magellan, and at Stanley Harbour, Falkland Islands.

The Challenger brought home six specimens from the Falklands, at Station 315, January 27, 1876; lat. 51° 40′ S., long. 57° 50′ W.; depth, 5 to 12 fathoms; bottom, sand and gravel.

Molgula pedunculata, Herdman (Pl. V. figs. 1–3).

Molgula pedunculata, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 234.

External Appearance.—The shape is between irregularly spherical and pyriform, it is elongated transversely, and slightly compressed laterally; the ventral edge forms a short thick stalk while the rest of the body is globular. The anterior end is flat and broad, and becomes continuous at its ventral edge with the short stalk. The dorsal edge

and the posterior end are strongly convex; the body is attached by the extremity of the produced ventral edge. The sides are slightly convex.

The apertures are both on the wide anterior end. They are sessile, and not conspicuous; the branchial is at the ventral edge of the anterior end just above the stalk; it is indistinctly six-lobed, and directed anteriorly and slightly ventrally; the atrial is at the dorsal edge of the anterior end, it is distinctly four cleft, and directed dorsally and a little anteriorly.

The surface is even, but finely roughened all over with a minute granulation.

The colour is white with a hyaline tinge.

Length of the body (antero-posterior), 4 cm.; breadth (dorso-ventral), 5 cm.

The Test is cartilaginous, thick and strong. It is smooth and glistening on the inner surface. The texture is very compact, and no vessels are visible.

The Mantle is not very thick. The muscle bands are irregular, they are distinct but distant. The branchial and atrial siphons are well developed.

The Branchial Sac is not thick, and has seven folds upon each side. The internal longitudinal bars are strong; there are usually about six on a fold, and several in the space between two folds. The transverse vessels are variable, and sometimes irregular; horizontal membranes are usually present. The stigmata are arranged in irregular transverse rows, rarely in spirals.

The Dorsal Lamina is short, but very wide; it is thin, and there are no ribs nor marginal teeth.

The Tentacles are large, branched, about twelve in number, and of two sizes placed larger and smaller alternately. One very large one occurs at the ventral edge, just anterior to the extremity of the endostyle.

The Dorsal Tubercle is situated a long way posterior to the tentacular circlet; it is equidistant from the branchial and atrial siphons, is somewhat reniform in outline, and is elongated antero-posteriorly. The horns are simply turned in, not coiled; the opening is directed dorsally and to the left.

This species is very unlike a *Molgula* in external appearance, and would much more readily be referred to the Cynthiidæ at first glance, while in some respects it appears to have affinities with *Ascopera*. The position of the stalk is peculiar (Pl. V. fig. 1). It is a prolongation of the ventral edge, and is more anterior than posterior; hence, in the natural position of the animal, the atrial aperture is higher and more prominent than the branchial. There are no hair-like processes on the outer surface of the test, and no incrusting sand, but the surface is finely granulated all over.

The mantle is not very muscular, the bundles being rather distant (Pl. V. fig. 2). There are circular bands on the prominent branchial and atrial siphons, from each of which a series of radiating bundles issues. The edge of the branchial siphon is indistinctly six-lobed, while the atrial is square (Pl. V. fig. 2).

The branchial sac has the stigmata rather irregularly arranged (Pl. V. fig. 3). In some places they form transverse rows, while in others they run obliquely or in spirals. The transverse vessels are often imperfect, but horizontal membranes are generally present, and extremely delicate ones, running only for short distances, may be seen here and there (Pl. V. fig. 3). This branchial sac in some of its features indicates an approach to the Cynthiad type. The lips of the endostyle are prominent.

One of the larger tentacles, placed on the ventral edge of the circlet, greatly exceeds the others in size. This disproportionate development of one of the tentacles is also found in a species of *Culeolus* (*C. wyville-thomsoni*), but there it is the most dorsally placed tentacle that is gigantic.

The great distance of the dorsal tubercle from the tentacular circlet is notable. It lies immediately under the nerve ganglion, which is seen in Pl. V. fig. 2, at the base of the atrial siphon.

One specimen of *Molgula pedunculata* was obtained to the south of Kerguelen Island, at Station 150, on February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bot. temp. 1°·8 C.; hard ground.

Molgula horrida, Herdman (Pl. V. figs. 4–7).

Molgula horrida, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 235.

External Appearance.—The body is rudely ovate, inclined towards quadrangular in shape, and somewhat compressed laterally. The anterior end is wide, rather truncated, and convex in its ventral part. The posterior end is wider than the anterior, it is convex but flattened in the middle. The ventral edge is strongly convex, with a depression in the middle of its length; the dorsal is concavo-convex, going from the anterior to the posterior end. The body is attached by the ventral part of the left side. The apertures are both on the right side near the anterior end; they are not distant, are slightly projecting, and have the lobes irregular. The branchial is half-way from the ventral edge to the centre; the atrial is near the dorsal edge.

The surface is irregular and rough, and is almost entirely covered with sand and adhering animals.

The colour, when the test is visible, is dull brown.

Length of the body, 5 cm.; breadth of the body, 5 cm.

The Test is thick, solid, and very stiff. It is smooth and glistening on the inner surface.

The Mantle is very thick but not muscular, the bands being very fine. The siphons are wide, funnel-shaped, and distinctly lobed.

The Branchial Sac is very thick, is of a dark green colour, and has seven folds on each side. The transverse vessels are irregular, in fact generally indeterminable, being

broken up into a system of branching and anastomosing tubes, which form the bases of the infundibula. Large square meshes are, however, marked out by the intersection of wide horizontal membranes with the internal longitudinal bars, and each of these meshes contains a number of infundibula. The internal longitudinal bars are prominent, and are connected by wide horizontal membranes, from which, as well as from the bars, other more delicate oblique membranes spring; these run in all directions over the inner face of the sac. The stigmata are long, coiled spirally, and crossed here and there by delicate radiating tubes.

The Dorsal Lamina is short, and quite plain, with no ribs nor teeth.

The Tentacles are large and branched; they are ten in number, with some additional very small intermediate ones.

The Dorsal Tubercle is prominent, and is elongated antero-posteriorly; both horns are much coiled, forming large spirals.

This dark, rough, and irregular-looking species has a large part of the outer surface covered with adhering sand, &c., but there are no hair-like processes upon the test. Both apertures are rather irregular, but the four atrial lobes are tolerably well marked (Pl. V. fig. 4). The mantle, branchial sac, and tentacles are all of a dark green colour; and the mantle and branchial sac are very thick and opaque. The siphons (Pl. V. fig. 5) are prominent and funnel-shaped, with their margins beautifully and distinctly lobed, the branchial having six and the atrial four. The musculature is close but very fine, and is quite different from the characteristic Molgulid arrangement. On the right side the mantle as usual is thinner over the region of the renal organ, the outline of which shows through (Pl. V. fig. 5).

The figure of the branchial sac (Pl. V. fig. 7), though correct as to the form and position of the parts, does not represent well the depth of the infundibula and the thickness of the sac. The interstigmatic vessels are delicate, and are coiled spirally, the different turns of the spiral being frequently connected by fine radiating tubes. Delicate oblique membranes (Pl. V. fig. 7, *o.m.*) are present in considerable number, running irregularly over the inner face of the infundibula, and attached to the network formed by the broken up transverse vessels.

The dorsal tubercle is large and prominent. It lies in a shallow triangular peri-tubercular area (Pl. V. fig. 6), but extends nearly up to the tentacular circlet.

The genital gland on the right side, placed anteriorly to the renal sac, is large and flask-shaped, having a short wide duct attached at its upper end. The mouth of the duct has its margin cut up into several long delicate finger-like processes.

Two specimens, adhering together, were obtained at the Falkland Islands from Station 315, January 27, 1876; lat. 51° 40′ S., long. 57° 50′ W.; depth, 5 to 12 fathoms; sand and gravel.

Molgula forbesi, Herdman (Pl. V. figs. 8–11).

Molgula forbesi, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 236.

External Appearance.—The body is globular in shape, slightly elongated dorso-ventrally, and not compressed laterally. The anterior end is slightly projecting, narrow, flattened, and has a siphon at each extremity. The posterior end is wide, and regularly rounded. The dorsal and ventral edges are both extremely convex; the body is not attached. The apertures are both at the anterior end, they are not distant, but are slightly prominent. The branchial is at the ventral edge of the anterior end, and is turned ventrally; the atrial is at the dorsal edge, and points anteriorly, it is more prominent than the branchial.

The surface is entirely covered with a close coating of sand grains. The colour is dull brown (due to the sand).

Length of the body, 1·8 cm.; breadth of the body, 2 cm.

The Test is not thick but stiff; it is quite opaque.

The Mantle is thin and transparent, the viscera being seen through distinctly. The muscle bands are numerous, but very fine. There are a few stronger circular bands round the short tubular siphons, and a series of longitudinal bundles radiate from the base of each siphon.

The Branchial Sac is rather delicate, and has seven folds upon each side. The transverse vessels vary greatly in calibre and position, and are often quite irregular. The internal longitudinal bars are strong, and there are three or four on each fold. The stigmata are very irregular, being straight, and arranged in transverse rows in some places, while in others they are curved, and form spirals, or run irregularly. Delicate horizontal membranes are frequently present, running from fold to fold. There are also more irregular longitudinal and oblique membranes.

The Dorsal Lamina is a short and narrow membrane with a plain edge.

The Tentacles are compound, situated on a strong muscle band. There are about twelve large and twelve small placed alternately.

The Dorsal Tubercle is simple, and placed at the posterior end of a deep and irregular peritubercular area. The left side of the tubercle extends further anteriorly than the right; both horns are turned to the left.

I have dedicated this elegant little species to Professor Edward Forbes who founded the genus *Molgula*. It has a globular shape (Pl. V. fig. 8) with the apertures at the anterior end, forming what are evidently permanent projections, since the sandy coating extends over them up to the very edge of the apertures.

The mantle is very delicate and quite transparent, allowing the viscera to be seen through distinctly (Pl. V. fig. 9). The branchial sac is also delicate, and the folds

are slight, with generally three or four internal longitudinal bars upon each (Pl. V. fig. 10). Usually there are no bars on the spaces between the folds, but sometimes one may be present. These spaces are, however, traversed by narrow membranes, horizontal, oblique, and longitudinal—the horizontal ones (Pl. V. fig. 10, *h.m.*) indicating the positions of the irregular transverse vessels. The stigmata are in some places arranged in complicated spirals, while in others they form more or less regular transverse rows (Pl. V. fig. 10).

The dorsal tubercle (Pl. V. fig. 11) is much simpler than is usual in the genus. It is not prominent, and the horns are not spirally coiled, but merely turned posteriorly. The peritubercular area is large and irregularly triangular, the peripharyngeal bands bounding it laterally having an undulating course.

The intestine (Pl. V. fig. 9) is long and narrow, and the loop turns anteriorly towards the branchial aperture, so as to partially enclose the left genital gland.

One specimen was obtained at Port Jackson, Australia. Depth, 2 to 10 fathoms.

Molgula pyriformis, Herdman (Pl. VI. figs. 1–3).

Molgula pyriformis, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 236.

External Appearance.—The body is pyriform or almost triangular, and is compressed laterally; it is not attached. The anterior end is wide, straight, truncated, and has an aperture at each extremity; the posterior is narrow and pointed. The dorsal and ventral edges are both convex. The widest point is at about one-third of the length from the anterior end, and from this point the two edges taper rapidly to the narrow posterior end. The apertures are at the extremities of the flat anterior end, they scarcely project, and are inconspicuous. The branchial is rather the more anterior of the two, and the more prominent, and is directed ventrally; the atrial is quite sessile, and points anteriorly.

The surface is entirely covered with a close coating of fine sand.

The colour is dark brown (due to the sand).

Length of the body, 2 cm.; breadth of the body, 1·5 cm.

The Test is thin but stiff, and quite opaque.

The Mantle is thin, with the musculature moderately developed. The strongest bands are those that radiate from the bases of the branchial and atrial siphons. Over the rest of the mantle the commonest form of muscle band is a short thick fusiform clump of fibres.

The Branchial Sac is delicate, with seven folds on the right side and six on the left. These folds do not include the stigmatic part of the branchial sac, but are merely formed of two or three additional internal longitudinal bars united by short transverse ducts, and thus forming an open network. There are no transverse vessels distinct from the fine interstigmatic tubes, but narrow horizontal membranes are present running transversely from fold to fold across the intervening space. The fine interstigmatic vessels are

arranged in rather distant and irregular longitudinal rows of spirals. The stigmata are large, they are curved in the spirals and more or less linear between. Delicate radiating tubes are frequently present.

The Dorsal Lamina is a plain narrow membrane.

The Tentacles are branched, but not large; they are numerous and of many sizes, arranged indefinitely.

The Dorsal Tubercle is very simple, and is tubular; it has a wide funnel-shaped aperture anteriorly, which rapidly narrows as it runs backwards and becomes lost in the neural gland. The peritubercular area is large and triangular.

This species has a curious external form, the posterior end, contrary to the usual rule, being narrow and pointed, while the anterior is broad and flat (Pl. VI. fig. 1).

The mantle is not very muscular, and over the greater part of its area the fibres are arranged, chiefly three to six or more together, in short fusiform clumps which taper suddenly at the two extremities and end in long delicate filaments.

The chief characteristic feature in the branchial sac (Pl. VI. fig. 2) is the structure of the folds. These are very simple and consist merely of two or three additional internal longitudinal bars attached to each normal one by short transverse ducts, like the connecting ducts from the transverse vessels. These ducts are placed in the same line with the horizontal membranes, and thus seem to indicate the position of the transverse vessels (Pl. VI. fig. 2, *h.m.*). In some of the folds there are twice as many ducts between the second and third internal longitudinal bar as between the first and second, so that if, for example, the first and second bars were connected by a transverse duct at every millimetre the second and third bars would be connected by ducts at every millimetre and every half millimetre.

There are seven folds on the right side of the sac and only six on the left, but, as the collection contains only one specimen of the species, this may be an individual abnormality. The stigmata are large and in some places are arranged in spirals, forming shallow infundibula. Between the spirals the stigmata are generally linear, and form irregular transverse rows. They are frequently crossed by narrow tubes (Pl. VI. fig. 2).

The dorsal tubercle is extremely interesting. It is in the simplest possible form, being merely the widened aperture of the duct from the neural gland. This duct may be seen distinctly (Pl. VI. fig. 3) running anteriorly and swelling out to form the large funnel-shaped aperture. It is placed near the anterior end of the large and deep triangular peritubercular area, which extends so far posteriorly as to include in its area the greater part of the neural mass (Pl. VI. fig. 3, *n.*).

A single specimen of this species was dredged off the coast of Buenos Ayres, South America, at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Eugyra, Alder and Hancock.

Cynthia, Møller, Index Moll. Groenl. 1842. In part.
Eugyra, Ald. and Han., Hancock, On the larval state of *Molgula*, &c., Ann. and Mag. of Nat. Hist., ser. iv., vol. vi. p. 353, 1870.
Molgula, Kupffer, Jahresber. der Commiss., &c. 1874. In part.
Eugyra, Lacaze-Duthiers, Les Ascidies Simples des côtes de France, Arch. de Zool. expér. et génér., t. iv. p. 647. 1877.
Eugyra, Traustedt, Oversigt over de fra Danmark og dets nordlige Bilande Kjendte Ascidiæ Simplices, Vidensk. Medd. Nat. Foren. i Kjøbenhavn, 1879–80, p. 428.

Body globular, unattached. Branchial aperture six-lobed; atrial four-lobed.
Test usually thin and transparent, incrusted with sand or plain.
Branchial Sac with no folds. Internal longitudinal bars few, but broad and ribbon-like. Infundibula formed of regularly coiled vessels, which form a double spiral meeting at the apex.
Tentacles compound.
Genitalia forming a single mass situated on the left side close to the intestine.

The above definition of the genus is that of Hancock, slightly modified so as to admit a species such as *Eugyra kerguelenensis*, which has no glandular hairs on the outer surface of the test and is not incrusted with sand, and so as to be in accordance with the nomenclature of parts adopted in this work.

The main distinction between this genus and *Molgula* lies in the structure of the branchial sac, *Eugyra* being characterised by the entire absence of folds, the broad ribbon-like internal longitudinal bars, and the large and regularly coiled infundibula.

Eugyra kerguelenensis, Herdman (Pl. VI. figs. 4–9).

Eugyra kerguelenensis, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 237.

External Appearance.—The body is globular or slightly elongated dorso-ventrally and is not compressed laterally; it is not attached. The anterior end is broad, convex, and flattened in the centre between the two apertures; the posterior end is more convex. The dorsal and ventral edges are nearly equally rounded; the sides are convex. The apertures are both at the anterior end, they are not distant, and are conspicuous; the branchial is sessile, or almost so; the atrial is much more prominent, forming a short cylindrical projection pointing directly anteriorly.

The surface is even and smooth, with the exception of a few wrinkles round the apertures. There is no sand adhering.

The colour is a light transparent grey.

Length, including the atrial siphon, 2 cm.; breadth, 1·8 cm.

The Test is very thin and transparent, except on the atrial siphon and immediately around the branchial aperture where it is thicker.

The Mantle is thin and membranous, and the musculature is extremely feeble; with the exception of a few bands radiating from the apertures, there are almost no muscular fibres.

The Branchial Sac is strong, and not folded. The internal longitudinal bars are in the form of broad ribbon-like bands. The transverse vessels are slight and irregular; narrow horizontal membranes are usually present. The infundibula are large, and are usually square or pentagonal at the base. The fine interstigmatic vessels are narrow and much coiled, the spiral having from ten to thirty turns (generally fifteen to twenty). The radiating vessels are slight, a few short intermediate ones are frequently present.

The Dorsal Lamina is a plain broad membrane.

The Tentacles are branched and delicate; they are numerous, about twelve large and twelve smaller, and three orders of simple and very minute ones alternate regularly.

The Dorsal Tubercle is simple, having an elongated oval cavity ending in a quadrangular aperture anteriorly. It is placed in a shallow triangular peritubercular area.

This is the fourth species of *Eugyra* known to science, the three others being *Eugyra glutinans*, Møller (=*Eugyra arenosa*, Alder), *Eugyra pilularis*, Verrill, and *Eugyra globosa*, Hancock. The discovery, so far south as Kerguelen Island, of a member of this genus, which has been hitherto found only in the northern hemisphere, is very interesting.

This species, though having all the characters of *Eugyra* well marked, differs from the three previously known species in many particulars. Perhaps the most notable difference is in the external appearance, as *Eugyra kerguelenensis* has a delicate transparent test with no adhering sand, and has the atrial aperture permanently projecting on a short cylindrical siphon (Pl. VI. figs. 4 and 5). The specimen represented in figure 5 differs considerably from what is probably the normal condition of the species as shown in figure 4. In internal structure, however, they are identical, and undoubtedly belong to the same species. Probably figure 5 is a somewhat abnormal specimen.

The mantle is remarkably thin, and, with the exception of the bands radiating from the apertures, there are almost no muscles, only a few delicate fibres being placed at considerable distances.

The shallow infundibula in the branchial sac (Pl. VI. fig. 8) are large and have a great number of coils in the spiral; up to thirty have been found, but the usual number is between fifteen and twenty (Pl. VI. fig. 8). Besides the delicate radiating vessels which extend from the angles into the centre of the infundibulum, there are usually present some intermediate ones of shorter extent (Pl. VI. fig. 8, *r.v'.*).

The tentacles are delicate but very numerous. There are five distinct sizes, the two larger of which are always compound, and the three smaller usually simple (Pl. VI. fig. 6). If we number them from A to E, according to their size, the arrangement will be found to be as follows:—A, E, D, E, C, E, D, E, B, E, D, E, C, E, D, E, A (Pl. VI.

fig. 6). The series A are by far the largest, and are usually much branched. The membrane on their posterior (branchial) surface is loose and voluminous (Pl. VI. fig. 7, *tn. m.*).

The dorsal tubercle (Pl. VI. fig. 9) is very simple, and approaches in structure that of *Molgula pyriformis* (Pl. VI. fig. 3). The duct from the neural gland swells out at the posterior angle of the peritubercular area into an elongated oval chamber, which opens anteriorly by a simple quadrangular mouth.

Three specimens of this species were obtained at Kerguelen Island. One is labelled "Kerguelen, 10–60 fathoms;" one "January 29, 1874, off London River, Kerguelen, 100 fathoms;" and one "Kerguelen, 10–100 fathoms."

Family CYNTHIIDÆ.

Body usually attached, rarely free, sometimes pedunculated.

Test membranous or coriaceous, rarely cartilaginous or covered with sand. Branchial aperture four-lobed, atrial four-lobed.

Branchial Sac longitudinally folded; internal longitudinal bars not papillated; stigmata straight, never forming spirals.

Tentacles simple or compound.

Intestine on the left side, slightly or not at all attached to the mantle.

Genitalia on the inner surface of the mantle, either on both sides or on one only.

The Cynthiidæ, and especially those forming the sub-families Bolteninæ and Cynthinæ, which have compound tentacles, are not far removed from the Molgulidæ, and were only separated as a distinct family by Lacaze-Duthiers in 1877. Heller previously (1874–77) considered them as one family. The Cynthiidæ form a very large group, and contain probably more known species than the other three families of Ascidiæ Simplices put together.

Savigny, in 1816,[1] founded two of the genera comprised in this family, namely *Boltenia* and *Cynthia*. The latter genus as defined by Savigny may be split up into two well-marked sections—one containing the typical forms (the modern *Cynthia*), in which there are many folds in the branchial sac and the tentacles are compound; and the other including the *Styela*-like forms with only four folds on each side of the sac and simple tentacles.

As each of these three types has been split up into genera I have thought it best to consider them as sub-families, and they were described in the Preliminary Report[2] as the Cynthinæ, the Bolteninæ, and the Styelinæ.

The condition of the apertures though rather variable is quite characteristic; there are never more than four well-marked lobes round either branchial or atrial apertures.

[1] Mémoires sur les Animaux sans Vertèbres, pt. 2, fasc. 1.

[2] Proc. Roy. Soc. Edin., Session 1880–81, p. 53.

Usually both openings are either four-lobed or cross-slit—that is, the lobes are triangular, and fit together so closely as to reduce the apertures to four narrow slits, radiating from a point so as to form a cross (Pl. XX. fig. 1). In the genus *Culeolus* (belonging to the sub-family Bolteninæ), however, the apertures have each less than four lobes, the branchial being triangular and the atrial bilabiate.

The shape of the body varies greatly, more than in any other family; ranging from the squat blister-like *Styela grossularia* to the long pedunculated *Boltenia*, and including a number of irregular and curious forms such as the species of *Microcosmus*.

The condition of the test is also variable, and can hardly be said to characterise the family. In the majority of the species, however, and in the most typical forms (those belonging to the Cynthinæ), the test is leathery, comparatively thin, but tough and roughened on the outer surface. In some species (*e.g.*, *Boltenia pachydermatina*, *Culeolus wyville-thomsoni*, &c.) it is thick and cartilaginous, while in a few remaining cases (*e.g.*, *Culeolus perlucidus*) it is thin and membranous.

The mantle is very muscular in the majority of the Cynthiidæ, and in its most highly developed condition consists of three layers of muscle fibres—an outer longitudinal and an inner longitudinal separated by a middle circular. In most cases, however, the inner layer is absent, and there are only the two well-developed layers, the outer longitudinal and the inner circular crossing at right angles.

In *Culeolus murrayi* and most of the other Bolteninæ they do not form continuous layers, consequently the musculature has the appearance of an open network formed by the longitudinal and circular bundles of fibres.

In some Cynthiidæ (*e.g.*, *Styela oblonga*) the musculature is very feeble, and is reduced to a few faint longitudinal bundles, while in *Styela flava* (Pl. XX. fig. 3) the arrangement of the fibres appears to be quite irregular, and no trace of longitudinal and circular layers can be made out.

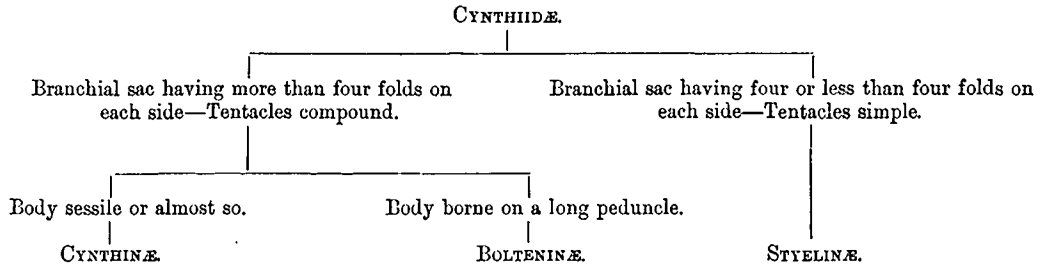
The branchial sac has longitudinal folds, and in typical members of the sub-family Cynthinæ they are very large, and sometimes numerous (at least twenty-four in *Cynthia grandis* according to Heller).[1] In the Styelinæ the folds are reduced in number and simplified. The typical number in this sub-family is eight, four on each side; this number is never exceeded, but is sometimes much reduced, as in *Styela grossularia*, van Beneden, where there is only a single fold.

In *Culeolus* and *Fungulus* the whole sac is much simplified by the absence of the system of fine longitudinal or interstigmatic vessels. In all the other Cynthiidæ the stigmata are straight, and are arranged in regular transverse rows.

The tentacles are compound in the sub-families Bolteninæ and Cynthinæ and resemble those of the Molgulidæ, but in the Styelinæ they are simple and filiform as in the Ascidiidæ.

[1] Beiträge zur nähern Kenntniss der Tunicaten, p. 15, Sitzber. d. k. Akad. d. Wiss., Bd. lxxvii., Abth. 1, 1878.

The chief differences between the sub-families may be shown in a tabular form thus :—



Sub-Family BOLTENINÆ.

Body attached and pedunculated ; branchial and atrial apertures having either four or less than four lobes.

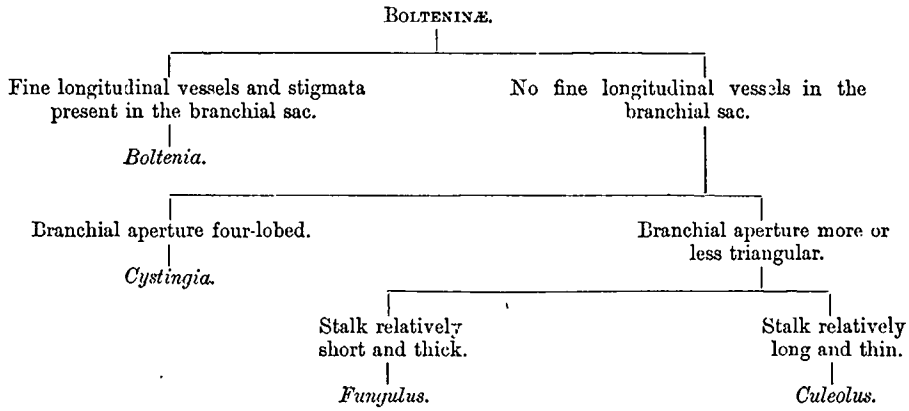
Test coriaceous, membranous, or cartilaginous, not covered with sand.

Branchial Sac with more than four folds on each side.

Tentacles compound.

This sub-family was formed[1] for the reception of *Boltenia*, Savigny, *Cystingia*,[2] Macleay, and the new genera *Culeolus* and *Fungulus*, discovered by the Challenger Expedition. It is more nearly allied to the Cynthinæ than to the Styelinæ, as it agrees with the former group in having compound tentacles, and more than four folds on each side of the branchial sac. The Bolteninæ are distinguished from the Cynthinæ by the long peduncle upon which the body is borne.

The genera in the sub-family may be arranged in a tabular form as follows :—



[1] Preliminary Report, part iii., Proc. Roy. Soc. Edin., 1880–81, p. 53.

[2] This form, described by Macleay in 1823, was brought from the arctic seas, and, so far as I am aware, it has not been found since. From Macleay's description it evidently belongs to the Bolteninæ, and is closely allied to *Boltenia*. The branchial aperture is described as four-lobed, and the atrial as irregular. The branchial sac is folded, and is stated to have no branchial network ; possibly it is like that of *Culeolus* (see below, p. 90).

Boltenia, Savigny.

Vorticella, Linnæus, Mant. Plant., p. 552. 1771. In part.
Ascidia, Müller, Prod. Zool. Dan. 1776. In part.
Boltenia, Savigny, Mém. sur les Anim. sans Vert., pt. ii. fasc. 1. 1816.

Body more or less globular, fixed on a long peduncle; apertures lateral, four-lobed.
Test coriaceous or cartilaginous.
Branchial Sac longitudinally folded, with six or more folds on each side. Fine longitudinal vessels present, forming straight stigmata.
Tentacles compound.

This genus was founded by Savigny,[1] in 1816, for the reception of pedunculated Simple Ascidians with a coriaceous test. At that time it contained the species described long before by Bolten (1770), but not named till the following year by Linnæus, and a new species *Boltenia ovifera*, Savigny.

Other species have been added to the genus since by Agassiz, Stimpson, Heller, and others, and finally two new species have been discovered by the Challenger expedition.

Boltenia elegans, Herdman (Pl. VII. figs. 1–5).

Boltenia elegans, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 80.

External Appearance.—The body has a quadrangular ovate shape, and is not flattened laterally; the anterior and posterior ends are bluntly rounded, and the dorsal and ventral edges are nearly straight; behind the atrial aperture the dorsal edge sinks in somewhat towards the posterior end. The peduncle is long and thin, wiry, attached to the ventral edge of the anterior end, and turned slightly ventrally. The apertures are conspicuous; the branchial is at the dorsal edge of the anterior end, directed anteriorly and dorsally; the atrial is on the dorsal edge, two-thirds of the way down, and directed dorsally and posteriorly.

The surface is smooth and glistening, but marked by a few creases. The colour of the body is white, with a satiny lustre; of the stalk light yellowish brown.

Length of body, 5.5 cm.; breadth of body, 4 cm. Length of stalk, 36 cm.; thickness of stalk, 2 mm.

The Test is thin but tough.

The Mantle is strong, and the musculature regular.

The Branchial Sac has nine folds on each side, those next the endostyle being closer than the dorsal ones. The transverse vessels are wide and distant. The internal longitudinal bars are narrow but well marked, and run at right angles to the stigmata, which are transverse, lying between narrow longitudinal bars which connect the transverse vessels. The stigmata are rather long and narrow, there are about fifteen in each mesh.

[1] Mém. sur les Anim. sans Vert., 2e pt. 1e fasc. p. 87.

The Dorsal Lamina is represented by a series of closely placed, large, tapering languets.

The Tentacles are large, and branched; they are sixteen in number, placed long and short alternately.

The Dorsal Tubercle is large and distinct, elongated transversely but directed vertically, the opening being on the right side; both horns are coiled inwards.

This species seems at first sight very like Savigny's *Boltenia ovifera*, but they differ in many particulars. The resemblance is chiefly in the external appearance (Pl. VII. fig. 1), but the surface and colour are different, *Boltenia ovifera* being rougher and darker. There is a species of *Boltenia* in the British Museum collection, unnamed but labelled "from Australia," which is also very similar to *Boltenia elegans*, and may possibly be the same species.

The test is thin and allows the direction of the chief bundles of muscular fibres to be seen through it in places. The muscle bands of the mantle are strong but do not form a continuous layer. There are a number of distant parallel bands running down the long axis of the body, and intersecting two series of bundles radiating from the apertures, so as to form roughly quadrangular meshes (Pl. VII. figs. 1 and 5, *m. b.*).

The branchial sac is remarkable, and has eighteen folds, nine on each side. Those next the endostyle are more closely placed and smaller than the dorsal ones. The transverse vessels are wide and distant, and the narrow internal longitudinal bars run at right angles to them so as to form the usual series of meshes (Pl. VII. fig. 2, *tr.* and *i.l.*). The fine longitudinal or interstigmatic vessels, however, run transversely in place of antero-posteriorly, and as a result the stigmata are directed transversely, and cross behind the internal longitudinal bars in place of running parallel to them (Pl. VII. fig. 2, *l. v.*). The languets and tentacles show nothing noteworthy.

The dorsal tubercle is large and has both horns coiled inwards (Pl. VII. fig. 3, *d. t.*). It lies in a moderately deep, triangular, unsymmetrically-shaped peritubercular area.

The intestine lies upon the left side of the branchial sac, and is seen in Plate VII. fig. 4. The œsophageal aperture (*œ. a.*) is placed far back in the sac, and the canal leading from it—there is no distinct stomach—runs along the ventral edge of the left side till it reaches the anterior end of the body, where it sweeps round dorsally, and makes two or three zig-zags along the dorsal edge (*i.*), so as to reach the posterior end where the anus (*a.*) is placed. This is a wide aperture with a beautifully fringed margin; it is close to the atrial aperture, and points posteriorly and dorsally.

The genital masses are present on both sides (Pl. VII. figs. 4 and 5) in the form of elongated many lobed slightly branched organs directed antero-posteriorly, and terminating close to the atrial aperture in a short genital duct (Pl. VII. figs. 4 and 5, *o. d.*). The left genital mass is rather the larger of the two, and lies chiefly in the intestinal loop.

Two specimens (one somewhat damaged) were obtained south of Halifax, Nova Scotia, at Station 48; May 8, 1873; lat. 43° 2′ N., long. 64° 2′ W.; depth, 51 fathoms; hard bottom.

Boltenia legumen, Lesson.

Boltenia legumen, Lesson, Centurie Zoologique, p. 149, pl. liii. fig. 1 (1830).
Boltenia coarcta, Gould, A. A., Mollusca, U. S. Explor. Exped. under C. Wilkes. Boston, 1852.
(?) *Boltenia legumen*, Cunningham, the Nat. Hist. of the Straits of Magellan, Edin., 1871, pp. 111 and 263, and Notes on Reptiles, &c., obtained during the voyage of H.M.S "Nassau," Trans. Linn. Soc., vol. xxvii. p. 489.
Boltenia legumen, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 81.

The *Boltenia coarcta* of Gould is evidently the same species as *Boltenia legumen*, which is figured by Lesson, and is an easily recognised species. Cunningham's figure (Straits of Magellan) shows rather a different outline, but it is probably the same species. The Challenger specimens are of various sizes, ranging from 1·3 cm. to 7 cm. in length, and from 1·2 cm. to 3·5 cm. in breadth. The shape of the body is ovate or ellipsoidal, and it is fixed by a short, sometimes twisted peduncle attached to the ventral edge of the posterior end of the body, and running downwards at right angles to the ventral edge, so that the body is supported with the dorsal surface upwards, and the anterior and posterior ends on the same horizontal plane.

The apertures are both on the upper surface, but rather far apart, the branchial being near the anterior end, and the atrial far back. Both are four-cleft, sessile, and very inconspicuous. The surface is very rough and covered with short bristle-like spines or hairs which are sometimes branched. The specimen from Station 312 might be considered as an echinated variety, as it has a dense coating of spines, which are usually much branched and serrated. The colour varies from yellowish-brown through various ruddy shades to a dark earthy brown.

The test is thin but very tough and leathery. The inner surface is pale coloured.

The mantle is moderately strong.

The branchial sac has seven folds on each side. The internal longitudinal bars are strong and numerous; there are about eight on a fold and the same number in the interspace, where the meshes are elongated transversely and contain each about ten stigmata.

The dorsal lamina is of no great breadth, but rather thick, so as to present the form of a triangle in section. The edges are uneven but not toothed, and ribs are present along the sides.

The tentacles are branched and of different sizes. There are twelve or fourteen, large and small alternately, with very minute ones placed here and there at the bases of the larger ones.

The dorsal tubercle, which lies in a small triangular peritubercular area, is large and prominent, and has a circular outline. The aperture is small and is directed forwards. Both horns are coiled inwards. The intestine forms a narrow loop.

The British Museum collection contains specimens of this species from "Philip Bay," "Falkland Islands," "Antarctic Seas," "Off Dungeness," "Mouth of Peckett Harbour," and "Possession Bay."

The Challenger specimens are all from the Straits of Magellan and the neighbourhood of the Falkland Islands, as follows :—

One specimen from Station 312, January 13, 1876; lat. 53° 38′ S., long. 70° 56′ W.; depth, 10–15 fathoms; bottom, mud. Eight specimens from Station 315, January 26, 27, 28, 1876; lat. 51° 40′ S., long, 57° 50′ W.; depth, 5–12 fathoms; bottom, sand and gravel. One specimen from Station 316, February 3, 1876; lat. 51° 32′ S., long. 58° 6′ W.; depth, 4–5 fathoms; bottom, mud.

Boltenia pachydermatina, Herdman (Pl. VII. figs. 6–8).

Boltenia pachydermatina, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 81.

External Appearance.—The body is between ovate and fusiform in shape, and is compressed laterally. The posterior (upper) end is bluntly pointed; the anterior end is narrow, becoming gradually continuous with the stalk; the dorsal edge is more convex than the ventral. The stalk is long, thick, twisted and creased, and rather tapering downwards towards the point of attachment. The apertures are conspicuous but not prominent, and not distant, being placed at the points of junction of the middle with respectively the anterior and posterior thirds of the body.

The surface of the body is smooth but deeply grooved longitudinally; the stalk is closely wrinkled transversely.

The colour of the body is dull creamy white; of the stalk, yellowish-brown.

Length of the body, 10 cm.; breadth, 5 cm.; length of the stalk, about 20 cm.

The Test is very thick, tough, and stiff, between cartilaginous and coriaceous in texture; it is white and glistening on the inner surface.

The Mantle is thin but muscular, and adheres slightly to the test.

The Branchial Sac has about six folds on each side. The internal longitudinal bars are numerous, about eight on the folds and six in the interspaces. The meshes are transversely elongated, and contain each about nine stigmata; they are always divided by a narrow bar.

The Tentacles are compound, and densely branched. They are sixteen in number, and of two sizes, placed large and small alternately. One of the tentacles is much larger than any of the others.

The Dorsal Tubercle is large, and circular in outline; the surface is marked with a close and elaborate pattern.

This large and striking species, although apparently common and well known, has, so far as I can ascertain, never been described or named. There are some very good specimens of it in the British Museum collection, labelled as follows:—New Zealand (about six specimens), Van Diemen's Land (about six specimens), Godthaal, Danish

Greenland, 80 fathoms (one specimen, labelled *Boltenia clavata*), New Zealand (about six specimens, labelled *Boltenia pedunculata*, M. Edw.), and some others with no locality marked. There are also some specimens in the Liverpool Free Public Museum, from Port Chalmers, Dunedin, New Zealand. They were brought home by Dr. Millen Coughtrey, and are labelled *Boltenia pedunculata*.

In external form this species is rather like *Boltenia bolteni*, Linn., but they differ in many details of structure. The above description is taken from the large specimen. The smaller one, which is figured (Pl. VII. fig. 6), differs slightly in external appearance in several respects, and has the test prolonged into a few short pointed processes scattered here and there over the sides and posterior end, which gives it somewhat the appearance of *Boltenia gibbosa*, Heller, quite a distinct species.

One of the most characteristic points in this species is the enormously thick test, of a solid cartilaginous consistency, which suggested the specific name.

The dorsal tubercle is very peculiar. It is large and circular in outline (Pl. VII. fig. 8), while the surface is marked by a number of branched ridges forming an elaborate pattern.

Two specimens (one large and one small) were obtained from Canterbury, New Zealand. They were presented to the expedition while at Wellington.

Culeolus, Herdman.

Culeolus, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880-81, p. 82.

Body fixed, pedunculated, more or less ovate; the anterior end, where the long peduncle is attached, narrower than the posterior. Branchial aperture more or less triangular. Atrial aperture bilabiate.

Test cartilaginous, often very thin, usually rough and papillated on the outer surface.

Mantle thin; musculature not greatly developed.

Branchial Sac with about six longitudinal folds on each side; consisting of transverse vessels and internal longitudinal bars forming a wide meshed network; there are no stigmata, the fine longitudinal vessels being absent. The larger vessels, especially the internal longitudinal bars, are supported by a system of branched calcareous spicules.

Endostyle also strengthened by numerous branched calcareous spicules.

Dorsal Lamina represented by a series of triangular languets.

Tentacles compound.

Alimentary Canal relatively small, placed posteriorly on the left side; stomach ventral, intestine turned anteriorly and dorsally, and rectum running posteriorly.

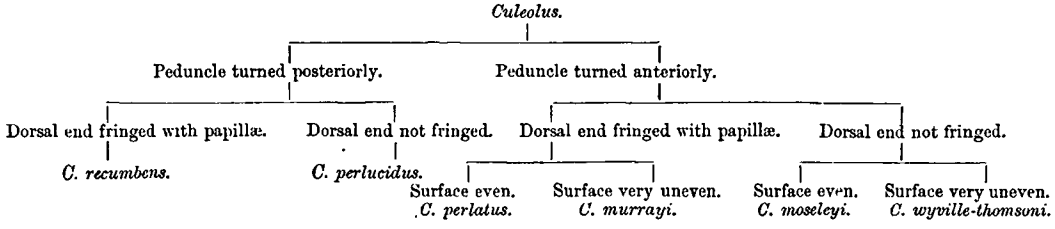
Genitalia on the inner face of the wall of the peribranchial cavity, developed on both sides of the body.

As *Culeolus* is one of the most interesting of the new genera which were collected during the Challenger expedition, I have gone more than usual into detail in the

following account. A short generic diagnosis, and a description of the six species for the reception of which the genus was formed, were given in the third part[1] of my Preliminary Report on the collection. The morphological peculiarities, however, were merely referred to; while histological details, and remarks on the structural characteristics and their bearing on our knowledge of the other members of the group, were omitted as being out of place in a Preliminary Report intended merely to supply a short description of the new species.

The genus *Culeolus* contains six species of Simple Ascidians, which in the first rough classification of the collection were arranged in the genus *Boltenia* on account of their long peduncles. A short examination, however, of their details of structure sufficed to show that they could not be referred to that or any other known genus. Further investigation revealed several peculiarities common to the species, such as the structure of the branchial sac, in which they differed from all previously known Simple Ascidians; it likewise showed that, although well-marked specific differences were present, and characteristics might be taken from almost every organ, the six species were closely allied, and possessed common characters, which rendered their union under one generic title necessary.

The species may be distinguished by means of external characters alone, as shown in the following table:—



Of three of the species—*Culeolus wyville-thomsoni*, *Culeolus perlatus*, and *Culeolus moseleyi*—only a single specimen was obtained, consequently in these the examination was limited to those points which were necessary for a diagnosis of the species, and the description below contains in addition only such observations as could be made without further injuring the unique specimens. The other three species, each of which is represented by more than one specimen, will be described more in detail, commencing with *Culeolus murrayi*, which may be taken as the type of the genus.

Culeolus murrayi, Herdman (Pl. VIII. and Pl. IX.).

Culeolus murrayi, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 83.

External Appearance.—Like the other species of the genus it consists of two parts, a more or less oval "body" borne on the summit of a long thin "peduncle" (Pl. VIII. fig. 1).

[1] Proc. Roy. Soc. Edin., 1880–81, p. 82.

The shape of the body is irregularly pyriform; it is not compressed laterally. The anterior end is narrow, and tapers into the upper end of the peduncle. The posterior end, on the contrary, is broad and bluntly rounded. The dorsal and ventral edges are irregular; they are, roughly speaking, parallel in their posterior two-thirds, and converge rapidly in their anterior third. The sides are equally convex, the body in transverse section being nearly circular.

The peduncle is of moderate length, thin but wiry, stiff but flexible, slightly undulating, though straight in its general course. It is a prolongation of the anterior end of the body, but at the point of junction turns dorsally at a right angle, so as to cross the branchial aperture; it is slightly enlarged at the upper and lower extremities, and elsewhere it is of uniform thickness.

The branchial aperture is placed close to the anterior extremity on its dorsal edge, consequently it is just under the peduncle (Pl. VIII. fig. 1). It is sessile but conspicuous, rather large and open, and triangular in shape—the base being anterior and the apex posterior. It is surrounded by a broad fringe of close-set minute papillæ or processes of the test, and is directed anteriorly and dorsally. The atrial aperture is distant from the branchial, being placed on the broad posterior extremity, a little to the dorsal side of the middle, and directed posteriorly. Like the branchial aperture it is sessile and large. It is bilabiate, in the form of a wide transverse slit, and is bordered by minute papilliform processes of the test.

The surface, which is rather irregular, being thrown into creases here and there, especially towards the posterior end, is finely granulated all over, while larger projections form thickened borders to the apertures, and are especially developed along a line encircling the body towards the posterior extremity. This line runs in an irregular undulating course round the posterior end, and thus surrounds the atrial aperture (Pl. VIII. fig. 1). It reaches the posterior end of the ventral edge, but dorsally it extends more anteriorly, so as to cut the dorsal edge about two-fifths of the way from the atrial to the branchial aperture. Where it crosses the ventral edge it is enlarged into a thickened mass of triangular shape, having the apex directed anteriorly; while in the dorsal region the belt narrows considerably, and the papillæ are of smaller size. The surface of the peduncle is nearly smooth, slightly ridged longitudinally in parts.

The colour of the body is a dull brown with a slate-grey tinge where the surface is least rough. The peduncle is of a pale slate-grey throughout.

The dimensions in the two specimens are as follows:—

	A.	B.
Length of the body (antero-posterior), .	6 cm.	5 cm.
Breadth of the body (dorso-ventral), .	4·5 „	3·2 „
Thickness of the body (lateral), . .	4 „	3·4 „
Length of the peduncle, . . .	15 „	9 „
Thickness of the peduncle, . . .	2 mm.	2 mm

The Test is moderately thick and strong, but quite soft and flexible. Its outer surface is rough on account of the presence of small processes scattered thickly all over, and developed in certain places into papilla-like tufts. These processes are of a brownish colour, while the test at their base has a slightly grey tint; where the processes are few or of small size this slate colour shows, elsewhere the general appearance is brown. The test is quite opaque.

On the inner surface, when the adhering mantle has been removed, the test has a pale hyaline blue tint, with minute dots or punctures all over it. Under a low power of the microscope (50 diameters) this appearance is seen to be caused by the presence of a large number of small chambers deeply imbedded in the test (as viewed from the inner surface). These are all very nearly of the same size, and are so numerous that the bars left between them seem to mark out the entire surface into polygonal areas. Most of these chambers in this view are seen to be occupied by masses of reddish-brown blood-corpuscles.

In thin sections through the test the minute papillæ on the outer surface are seen to be hollow (Pl. VIII. fig. 2, *t.p.*), and their large bases contain the chambers seen from the inner surface. These chambers or interior spaces of the papillæ extend, however, a little into the thickness of the test; they are in direct connection with the blood-vessels ramifying through the substance of the test, and frequently in sections one of the terminal twigs of the vessels is seen entering the base of a chamber (Pl. VIII. fig. 2, *t.k.'*). The vessels in this test seem rather feebly developed. They are not present in large numbers in any of the sections, and they are of small size. These chambers occupying the papillæ seem to be a modification of the knobs on the ends of the terminal twigs of the vessels so well developed in many species of the genus *Ascidia*, and like them are generally filled with blood-corpuscles. Lacaze-Duthiers states[1] that the hairs on the test in the Molgulidæ are merely the terminal knobs greatly developed in length. In the present case we have them extending beyond the surface of the test as a series of hernia-like papillæ. The larger projections, however, found round the branchial and atrial apertures, and on the belt round the posterior end, are comparable with the hairs of the Molgulidæ, although their function appears to be different, as I have never observed any foreign matter adhering to these processes. They are conical in shape, taper to a blunt point, and have usually a considerable number of short lateral branches which frequently bifurcate at the tip, and in some cases end in a clump composed of several little papillæ (Pl. IX. fig. 3, *t.k.'*). The whole process is hollow and very thin-walled. It is, like the chambers at the bases of the smaller papillæ, directly continuous with the blood-vessels of the test, and usually contains blood-corpuscles.

It is difficult to say what the use of these processes of the test can be. Their connection with the vascular system and their thin walls suggest a respiratory function,

[1] Archives de Zoologie expérimentale et générale, vol. iii. p. 314 (1874).

and, considering that the vessels of the test are by no means greatly developed, it would be of great advantage probably that the blood circulating in the test should undergo additional oxygenation.

The inner surface of the test is lined by a continuous layer of squamous epithelium. The cells are large, regular, and distinctly nucleated; they vary in shape from hexagonal to diamond-shaped, and are usually broadly fusiform.

The remainder of the test is composed of an apparently structureless mass (Pl. VIII. fig. 2, *t.m.*), like the matrix of hyaline cartilage, in which are imbedded minute, circular, fusiform, and stellate cells. A very delicate fibrillation may be detected here and there in the matrix, but as a rule it has a homogeneous appearance. The cells are very minute, and usually only the nucleus is visible. Often, however, a thin layer of protoplasm surrounding it can be made out, and from this delicate processes are occasionally seen radiating outwards so as to give the cell a stellate appearance. No large bladder cells nor pigment cells are present.

The blood-vessels in the test, and their large terminal dilatations in its outer layer are lined by a layer of squamous epithelium of extreme delicacy. The nuclei of the cells are always visible as a series of equidistant strongly refracting circular spots, dotting the walls of the vessels. In good specimens, however, the outlines of the cells are also distinctly seen. The cells are large, pretty equal in size, but irregular in shape; they are scale-like, usually polygonal, and have sometimes undulating edges. The nuclei are large, very distinct, circular in outline, and placed in the centres of the cells.

The peduncle is merely a prolongation of the test, and consists of the same structures somewhat modified so as to produce the necessary toughness and rigidity. In transverse sections under a low power (Pl. IX. fig. 1), one sees that the peduncle is not a solid mass, but is perforated by large canals, which show as more or less circular spaces in each of which one or more blood-vessels are situated. In longitudinal sections (Pl. IX. fig. 2), it is seen that these canals are not parallel tubes, but are irregular, branching, anastomosing, and of very different lengths, so that in fact they are merely a network of canals, most of which run longitudinally. Up the centre of the peduncle, however, runs a tube which is larger than the others, and appears to be continuous, and of much the same calibre throughout (Pl. IX. fig. 1). It communicates freely with the other canals by lateral branches.

The test substance in which these canals are excavated presents two different modifications. Round each canal, and round the outside of the peduncle is a layer of hyaline semi-transparent substance (Pl. IX. figs. 1 and 2, *t.m.*) like the compact part of the normal test covering the body. The matrix is compact, stains faintly pink with picro-carmine, and is apparently structureless, except in the immediate neighbourhood of the modified tissue, where it is fibrillated. It contains numerous protoplasts which are very minute, but distinctly nucleated. These are stained yellow by picro-carmine.

Outside this normal test substance, and therefore winding between the canals, are masses and trabeculæ of a bright yellow-brown tissue (Pl. IX. figs. 1 and 2, *t.m.c.*) concentrically laminated—appearing as longitudinal striation in longitudinal sections of the bars. An examination of this tissue shows that it is merely a modification of the neighbouring test substance caused by some sort of cornification taking place in successive layers so as to produce the concentric lamination. The bright yellowish-brown matrix is closely fibrillated, the bundles of fibrillæ running as a rule parallel to the concentric laminæ. In this fibrous matrix numerous protoplasts are imbedded; they are very minute, circular to fusiform in outline, and have comparatively large, brightly refracting, circular nuclei.

The blood-vessels occupying the canals (Pl. IX. fig. 1, *ped. c.*) and surrounded by the unmodified test substance are of various sizes. A large trunk, and occasionally one or more small branches from it, are found in the central large canal, while smaller vessels occupy the other spaces; like the canals they lie in, these vessels intercommunicate—they form a branching and anastomosing system. The wall of all these vessels consists of a single layer of cells. These are large and elongated, varying in shape from fusiform to oblong, and have large and distinct circular and centrally placed nuclei, and finely granular protoplasm. They lie with their long axes parallel to the length of the vessel, and in transverse sections appear as small round cells.

The Mantle is thin but moderately strong; it still (in spirit specimens) adheres to the inner surface of the test, but the connection is slight, as it may be peeled off with ease. The muscle bands are strong but distantly placed, so as to form an open network. Most of the bands run transversely to the longitudinal axis drawn through the point of attachment to the peduncle and the opposite extremity of the body, but a few longitudinal bands are also present, radiating from the branchial and atrial apertures; these lie internally to the transverse muscles. On the branchial and atrial siphons the muscle bands lie transversely, are more regular and parallel than elsewhere, and considerably closer; these can hardly be characterised, however, as sphincter muscles.

The muscle bands are flattened like ribbons, and contain on an average about fifty fibres in their breadth. The fibres are rather large, of a much elongated fusiform shape, and are closely packed in bundles. They stain deeply with carmine, but no distinct nuclei are visible. In teased bundles, however, some rather smaller fibres (or series of fibres) were noticed having swellings at intervals, or shaped like a series of spindles joined by their ends; these had distinct circular nuclei in the wider parts. No transverse stripes were observed in any of the fibres.

The greater part of the mantle is composed of connective tissue, which envelopes and stretches between the muscle bands. It is in the form of a thin layer of gelatigenous areolar connective tissue—a delicate transparent matrix, in many places apparently structureless, in others finely fibrillated, and sometimes formed of bundles of white

fibrous tissue, penetrated by numerous branching anastomosing spaces (the "pallial capillaries" of some authors), and containing round, oval, fusiform, and stellate connective tissue corpuscles.

The inner surface of the mantle is lined by a continuous layer of tesselated epithelium —the "parietal layer of the atrial membrane" of Huxley, and the "lining membrane" of Hancock. The cells are squamous, polygonal in outline, and rather large. The nuclei are comparatively small, circular, central in position, strongly refracting, and stain deeply with carmine.

The Branchial Sac is the most characteristic feature of the genus, and presents striking peculiarities. In the present species it is of considerable size, occupying the whole of one side of the body of the animal. To the naked eye it presents the appearance of a coarse network, the meshes being very large and the vessels of considerable calibre.

A closer examination shows that, as in all the Cynthiidæ, the sac presents certain folds running longitudinally (or from the branchial to the œsophageal aperture) and projecting from its internal surface. These folds are twelve in number, six on each side of the sac. They are of moderate size, not very prominent, but still distinctly visible. Those nearest to the dorsal edge of the sac are more distinct, and are more closely placed than those towards the ventral edge, the pair next the endostyle being very slight.

The structure of this branchial sac is simple in the extreme (Pl. VIII. fig. 3). There are two series of vessels—the transverse and the internal longitudinal bars. If the branchial aperture be placed superiorly the transverse vessels will be found running round the sac externally like a series of horizontally placed hoops, while the internal longitudinal bars lie in a plane internal to the transverse vessels, and run down the inner surface of the sac from the anterior to the posterior end. The two series of vessels thus cross at right angles and form a network with rectangular meshes. At their points of intersection—the angles of the meshes—the vessels intercommunicate.

The transverse vessels (Pl. VIII. fig. 3, *tr.* and *tr.'*) are of two kinds, larger and smaller; they are placed alternately, and the larger vessels are about three times as wide as the smaller ones. The meshes formed by the intersecting transverse and internal longitudinal vessels are oblong, and have their greater extent antero-posteriorly or at right angles to the transverse vessels. Over the greater part of the branchial sac, the proportion between the sides of the mesh varies from 3 : 4 to 3 : 6 and is in most cases about 3 : 5, so that the transverse vessels are placed from once and a-half to twice as far from one another as the internal longitudinal bars are. On the folds, however, the meshes are much more elongated, in consequence of the comparative crowding together of the internal longitudinal bars on these parts, while the transverse vessels are at the same distances as in other regions of the sac.

The folds (Pl. VIII. fig. 3, *br.f.*) are merely longitudinal tracts along which the

sac bulges to a greater or less extent into the interior of the cavity, so as to increase the area of the wall, and along which the internal longitudinal bars are present in greater number, and are therefore more closely placed than in other parts of the sac (Pl. VIII. fig. 3). In an average size of fold there are ten internal longitudinal bars, counting both sides of the fold, while, in the plain space between two folds, there are only four internal longitudinal bars. Yet that open space is nearly as wide as the fold would be if spread out, that is to say, it is nearly twice as wide as the fold in its normal doubled-up condition. In fact, on an average, the internal longitudinal bars are about twice as closely placed on the folds as they are elsewhere. They are not, however, placed at regular intervals, but become more and more closely placed as they approach the projecting edge or crest of the fold; while the first bar of the fold shows but little difference from the arrangement between the folds, the fourth, fifth, and sixth are so closely placed that the meshes are reduced in places to mere chinks, and are in some cases obliterated (Pl. VIII. fig. 3, *br.f.*).

A conspicuous feature in this branchial sac is the presence of spicules in the interior of the vessels (Pl. VIII. fig. 3, *sp.*). They lie in the inner part of the wall of the vessel, and are present in greatest number in the internal longitudinal bars, and especially near their points of intersection with the larger transverse vessels into which the spicules sometimes extend. I have never seen them in the smaller transverse vessels.

These spicules are composed of carbonate of lime, and are often of very considerable size, up to ·5 mm. in their greatest extent. There seems to be no prevalent form or plan of growth for them, though they have a characteristic appearance, as they are generally slender and branching, and the outline is formed of gentle curves, there being no sharp points or angles. The smallest and simplest forms noticed were minute fusiform spicula; these, when a little larger, began to have their outlines somewhat wavy, and frequently one of the ends was forked, or a slight branch had made its appearance near the middle. From this all stages of complication may be found up to the largest forms which are often considerably branched.

On examining these spicules closely with a high power, one notices that they are invariably marked by a series of delicate lines, of which the outer ones run exactly parallel to the outline of the spicule, following all its curves, while the more internally placed lines do so to a less degree, and finally the series ends near the centre of the spicule in a few concentric curves, the whole having the closest possible resemblance to a system of contour lines on a map (Pl. VIII. fig. 6). These markings no doubt represent stages in the deposition of the carbonate of lime. In some of the spicules, if not in all of them, there exists a central cavity, which may be prolonged along the branches to a considerable extent as fine canals, along which air and staining fluids were observed to pass in some of the broken spicula.

The wall of the vessels of the branchial sac is composed externally of a layer of thin

squamous epithelium. The cells are large, and have centrally placed round nuclei which stain brightly with carmine. On the internal longitudinal bars the cells become modified (Pl. IX. figs. 5 and 6). Towards the front or most internal part of each bar, the cells begin to become smaller in superficial area, but deeper, and with larger nuclei. This increases till they come to a series of cubical or short columnar cells, with large distinct nuclei, forming a band down the front of each bar. These columnar cells I expected to find ciliated, and probably they were so when living; I have searched for the cilia carefully, but in vain. The nuclei of all these cells stain brilliantly with carmine, and under a moderately high power where the outlines of the cells are not distinguishable, an internal longitudinal bar in profile presents a curious appearance (Pl. IX. fig. 5). The whole surface is scattered over with red dots, which are larger and very much more closely placed towards the internal free edge, while further out they diminish in size and are more distant.

The chief peculiarity about this branchial sac is its open network. The meshes formed by the intersection of the transverse and internal longitudinal bars (Pl. VIII. fig. 3, *mh.*) are perfectly patent, and are not filled up by any other structure, the entire system of fine longitudinal or interstigmatic vessels so generally present in the branchial sac being here completely absent; so that, strictly speaking, no stigmata are present, or, better still, the stigmata coincide with the meshes.

The Endostyle is a very conspicuous organ in this species. It is of considerable size, and has the edges of a bright opaque white colour, so that it is seen at once on looking into the branchial sac. As usual it has the form of a deep groove extending along the ventral edge of the branchial sac, and bounded laterally by raised pads. The bottom of the groove is of a rich brown hue, but the prominent edges are of a chalky white colour.

When a small piece of the endostyle is cut out and laid on a glass slide, the edges fall down outwards and leave the bottom of the groove exposed (Pl. VIII. fig. 4). One notices then that the central brown part (Pl. VIII. fig. 5, *c.b.a.*) consists of several narrow longitudinal bands along the middle, and two darker and broader bands at the sides (*l.b.b.*), all outside the latter being either transparent (*t.a*) or chalky white (*w.e.*). The central narrower bands are of various tints of brownish yellow, but none are so dark as the lateral bands. Outside these lateral bands is a broad translucent space (*t.a.*), and outside that comes the prominent white border (*w.e.*) which is now seen to owe its colour to a series of quadrangular white patches placed side by side, and of which every alternate patch is considerably brighter than the intermediate ones (Pl. VIII. fig. 4). In some parts of the endostyle the lateral brown pads are further from the centre than usual, and they then lie on the translucent area immediately inside the white edges.

A microscopical examination shows that the white colour of the patches forming the edges of the groove is due to the presence of a large number of calcareous spicules matted

together; and that the brown colour of the bottom of the groove is caused by the granular brown cell elements in that locality. The spicules are composed of carbonate of lime, and are very similar to those found in the vessels of the branchial sac, but here they are larger and considerably more branched. In the prominent white edge of the endostyle (Pl. VIII. fig. 5, *w.e.*) each of the quadrangular patches is a dense mass of spicules closely matted together in the centre, and rather more open at the edges where the tips of the branches are seen projecting. The different patches are united together by the branches which stretch from one to the other. The rather denser alternate patches send down branches of spicules into the translucent area (Pl. VIII. fig. 5), while the intermediate patches, which are not so dense, have no connection with that area.

The translucent area, immediately inside the prominent white edge, has a series of spicules stretching longitudinally along its centre and leaving a clear space along each side (Pl. VIII. fig. 5, *t.a.*). Some of these spicules are very complicated, extending for a great distance, and branching and uniting again so as to form a tangled mass. They are united to the spicules of the outer white edge by the branches which dip in from the denser patches, but have no connection with the spicules of the central brown area.

When the lateral brown bands encroach upon the translucent area they lie along the line of spicules, so as to leave a clear space separating them from the central brown area internally and from the white edge externally. The central brown area is also provided with spicules (Pl. VIII. fig. 5, *c.b.a.*), but here they are not nearly so prominent on account of the strong colour of the cells overlying them. The spicules are arranged in two longitudinal series leaving a clearer space in the middle, across which however they send branches which unite here and there. They extend laterally slightly beyond the brown area into the clear band on the inner side of the translucent area, and may even overlap the tips of the spicules of the translucent area, but they were never observed to unite with them.

Over the white prominent edge and the translucent area the epithelium forming the surface of the endostyle is clear and transparent. The cell elements, however, are distinctly visible. In surface view they are square or polygonal cells of moderate size provided with distinct dark nuclei. When seen in profile they are cubical. The lateral dark brown bands are formed of columnar epithelium. The cells are very long and narrow, and closely packed together. They taper towards their lower ends, and some of them towards their free ends also. The nuclei are only seen in the profile view of the cells and are variable in position, being usually in the widest part of the cells, sometimes near the free end but sometimes deep down. The surface view of these cells has the appearance of a very fine mosaic.

The central brown area constituting the bottom of the groove is composed of extremely long columnar epithelium apparently not ciliated. The cell elements are here rather difficult to distinguish. They are very greatly elongated, and are columnar or fusiform in

shape. No nuclei are distinguishable, but the cell contents are throughout brown and granular. A finely granular matter, in some places traversed by very delicate strings or fibrillæ, lay along the floor of the groove, covering the tops of the cells; but nothing of the nature of cilia could be detected in any part.

The Dorsal Lamina is replaced by a series of languets or tentacular processes (Pl. VIII. fig. 8, *l.*), which are disposed in a single line along the dorsal edge of the branchial sac from the apex of the peritubercular area anteriorly to the œsophageal opening posteriorly.

The languets are relatively long and are very closely placed (Pl. IX. fig. 14, *l.*). Each has an elongated triangular form tapering from the base where it is attached to the pointed free end. They are about 4 mm. long, and are very delicate and transparent, except along the lateral edges and the tip, where there is a thickened border.

The histological structure of the languets is exactly similar to that of the internal longitudinal bars of the branchial sac. They are hollow, and the thin walls are covered in the greater part of their extent by squamous epithelium, which becomes thickened towards the edges and the tip, where the cells are cubical, thus forming the darker border. These cubical cells do not bear cilia.

The Tentacles are large, much branched, and of various sizes (Pl. VIII. fig. 7, *tn.* and *tn.'*). They spring from the upper margin of the præbranchial zone, and just at their bases a strong muscular band, forming the most posterior part of the sphincter muscle, runs round the lower end of the branchial siphon. There are sixteen principal tentacles, eight larger and eight smaller, placed alternately; but between these there are others here and there of a very much smaller size and having no definite arrangement. A moderately sized member of the circle of eight larger tentacles (Pl. VIII. fig. 7, *tn.*) is about 12 mm. long, and has from twelve to twenty branches. Some of these branches are simple, while others, generally about the centre of the tentacle, bear simple lateral processes. The eight smaller tentacles (Pl. IX. fig. 12) are one-third to one-half of the size of the larger ones, and have generally eight to twelve processes.

The main axis of each tentacle is an elongated tapering sac with thin walls, and has a ridge or dark band running out from the base to the tip along the upper surface (Pl. IX. fig. 12), while the lower or branchial surface is soft and membranous. The pinnæ start off from the sides of the main axis rather towards the under than the upper surface, and each of them has along its upper edge a dark ridge, while the lower surface is membranous and plain as on the main axis. This membranous lower surface is also, both on axis and branches, irregularly puffed out, or thrown into a series of projections and folds, while the upper surface is straighter, and has the appearance of being more tightly stretched.

The surface of the tentacles is covered with epithelium, thin and tesselated over the greater part of the surface, thicker and columnar along the dark band on the upper edge

(Pl. IX. fig. 13a). The cells of the lower surface and sides are diamond-shaped or short fusiform, and have distinct point-like nuclei (Pl. IX. fig. 13b and c). Those of the band along the upper edge are cubical or low columnar, in most places the latter, and have nuclei placed near the lower end of the cell, and only seen in a profile view (Pl. IX. fig. 13e). A surface view of the dark band shows the ends of these columnar cells as a series of closely placed minute round areas (Pl. IX. fig. 13d). Underneath the epithelium in the tentacles are placed here and there large spicules similar to those of the branchial sac (Pl. IX. fig. 13a, *sp.*). In the interior of the tentacles may also be seen in many places small collections of the large round yellowish-brown blood-corpuscles (Pl. IX. fig. 13a, *b.c.*).

The Præbranchial Zone or the area lying between the branchial siphon and the branchial sac, and bounded superiorly by the circlet of tentacles and inferiorly by the peripharyngeal band, is in this species of moderate breadth (Pl. VIII. fig. 7). It is about one-third of the length of the larger tentacles, and the smaller tentacles mostly extend just across it to the peripharyngeal band. It is perfectly smooth, and is covered by squamous epithelium in direct continuity with that covering the lower surface of the tentacles.

The Peritubercular Area, or the dorsal offshoot from the præbranchial zone, in which the dorsal tubercle is placed, is triangular in shape (Pl. VIII. fig. 7, and Pl. IX. fig. 15), nearly symmetrical, and relatively large, being nearly twice as long as the breadth of the præbranchial zone.

The Dorsal Tubercle, better known perhaps as the "olfactory" tubercle, is small, and is situated down in the posterior angle of the peritubercular area (Pl. VIII. fig. 7, and Pl. IX. fig. 15, *d.t.*). It is, however, distinctly visible, and has the form of a hemispherical projection, on the surface of which is a deeply cut groove forming a crescent with both horns curled inwards. The horns are anterior and posterior, and the concavity is turned towards the left side.

The Peripharyngeal Band, bounding the præbranchial zone posteriorly, is well marked, and has the usual form of a pair of closely placed ridges separated by a narrow groove. At the dorsal edge of the sac, where the two halves of the peripharyngeal band turn posteriorly to bound the peritubercular area, the right half is rather higher or more anterior than the left (Pl. VIII. fig. 7, *p.p.*). At the apex of the peritubercular area the two halves unite at the anterior extremity of the dorsal lamina.

The Nerve Ganglion is of small size, and has an elongated fusiform shape (Pl. IX. fig. 15, *n.g.*). It lies immediately posterior to the dorsal tubercle, its anterior extremity overlapping that organ dorsally.

The Heart is situated on the right side of the body. It lies on the inner face of the mantle towards the ventral edge, about midway between the branchial and atrial apertures, and is placed longitudinally, running parallel with the endostyle, from which it is

not far distant. It is an elongated, fusiform, thin-walled sac, and is enclosed by a membranous pericardium composed of a thin layer of connective tissue uniting an open network of branched spicules similar to those found in the branchial sac, endostyle, &c. This is lined by a layer of squamous epithelium. The cells are large, polygonal in outline, and distinctly nucleated (Pl. IX. fig. 11).

The wall of the heart itself is composed of regularly arranged fusiform cells, interlocking with each other (Pl. IX. fig. 9). These cells are about twelve to sixteen times as long as they are broad, and are perfectly symmetrical, tapering gradually towards each end. They have large central distinct nuclei, which stain brilliantly in carmine and logwood. These cells are all distinctly striated transversely (Pl. IX. fig. 10). The striæ appear as dark bands, leaving clear spaces between them; there are usually about twenty in each cell.

The Alimentary Canal.—The first portion of the alimentary canal, consisting of the branchial sac or modified pharynx, has already been described; there remain still to be noticed the œsophagus, the stomach, the intestine, and the anus.

The œsophageal opening lies at the posterior end of the dorsal lamina near the posterior extremity of the branchial sac. It is an irregularly triangular aperture (Pl. VIII. fig. 8, *œ.a.*), surrounded by a membranous lip of considerable breadth, which is the termination of the dorsal lamina. The œsophagus (*œ.*) is a short tube running in a curved course posteriorly and ventrally so as to reach round the posterior end of the branchial sac. It then opens into the irregular stomach (*st.*). This organ lies along the ventral edge of the posterior end of the branchial sac, and has a remarkable appearance (Pl. VIII. fig. 8, *st.*). It is an irregularly elongated pyriform sac, having its intestinal or anterior end rather the larger; its walls are curiously folded and sacculated, so that in external view it is multilobed, and the lobes are covered with bunches of little rounded processes. From its anterior larger end the intestine emerges. It is long and simple, but rather twisted in its course, performing several slight undulations. It runs forwards along the ventral edge of the branchial sac for about half its extent, and then, turning abruptly, it runs back almost parallel to the first part of its course, but lying to the left of it, and after curving round dorsally it passes to the left of the stomach and last part of the œsophagus, to terminate close to the atrial aperture (Pl. VIII. fig. 8, *a.*). Just at the most anterior part of the intestine where it turns round, an irregular process projects from it into the narrow loop (Pl. VIII. fig. 8, *i.c.*). This is apparently a cæcum —possibly it may be an individual abnormality.

The whole of the intestine is thin walled, and its surface is smooth and of a dull leaden-grey colour. The wall of the stomach is thicker, and is of a pale yellowish-brown colour. There is no typhlosole or projecting fold of any sort in the intestine. The anal termination is slightly widened, and has an undulating free edge (Pl. VIII. fig. 8, *a.*). The intestine contained fine mud of a dull brown colour.

The Genital Organs consist of a series of about twelve rudely cubical masses, which adhere to the inner surface of the mantle proper, and are covered by the lining membrane of the peribranchial cavity, into which they project (Pl. VIII. fig. 10). They are situated rather towards the ventral edge and occur on both sides of the endostyle, the majority, however, being on the right side.

Each genital mass consists chiefly of a spherical spermarium or testis out of which leads a delicate somewhat undulating vas deferens. As the genital masses on each side are arranged in two or three converging series (Pl. VIII. fig. 10), the testes in each series are united by a vas deferens, and the several vasa deferentia then join to form a common duct (Pl. VIII. fig. 9, *v.d.*), which opens into the peribranchial space near the atrial aperture.

Round the vasa deferentia uniting the different genital masses, and round the genital masses themselves, lie the ova (Pl. VIII. fig. 11, *ov.*), and these continue up to the point of convergence, where there is a short wide membranous tube serving as an oviduct (Pl. VIII. fig. 9, *o.d.*) and opening alongside the common vas deferens.

The masses of ova are yellow, while the bunches of spermatic vesicles composing the testes (Pl. IX. fig. 17a and b, *t.v.*) are pale whitish yellow. The vasa deferentia show as opaque white lines running through the masses of ova. The ova are in various stages of development, very young ones, in which there is little vitellus round the germinal vesicle (Pl. IX. fig. 16b), being numerous. The more mature ova (Pl. IX. fig. 16a) are enclosed each in a capsule formed of cubical or low columnar cells (Pl. IX. fig. 16c).

Two specimens of this species, one of them somewhat injured, were obtained in the Pacific Ocean, west of Japan.

Station 241. June 23, 1875. Lat. 35° 41′ N., long. 157° 42′ E.; depth, 2300 fathoms; bottom temperature, 1°·1 C.; red clay.

Culeolus wyville-thomsoni, Herdman (Pl. X. figs. 1–6, and Pl. XIII. figs. 5 and 6).

Culeolus wyville-thomsoni, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 84.

External Appearance.—In this species the "body" part is rather larger and the peduncle shorter than in *Culeolus murrayi*. The general shape of the body (Pl. X. fig. 1) is irregularly pyriform, or almost wedge-shaped, on account of the great difference in the width at the two ends; there is no lateral compression. The anterior end, where the stalk is attached, is narrow and tapering. The posterior end, on the contrary, is very broad, but not so much rounded as in the last species. It is divided by the atrial aperture into a dorsal and a ventral portion. The latter is straight, has a truncated appearance, and forms almost a right angle with the posterior extremity of the ventral edge. The dorsal portion, on the contrary, is rounded off, forming a gentle curve, and becoming continuous with the dorsal edge. The dorsal and ventral edges are very irregular, more so

than in *Culeolus murrayi*, and diverge as they recede from the anterior end. The greatest width is reached at about two-thirds of the length of the body from the anterior end. From this point the ventral edge runs with a slight ventral inclination to meet the posterior end, while the dorsal edge curves round as described above. The sides are irregularly but about equally convex.

The peduncle is not long; it is thin, wiry, stiffer than in the last species, but not so flexible, and is bent in a gentle curve towards the dorsal side of the body. It is attached to the anterior end of the body, and turns dorsally at a right angle, so as to cross the branchial aperture (Pl. X. fig. 1). From its point of attachment it runs for a short distance partly imbedded in the test, and disappears on the ventral edge. It becomes thickened at the upper extremity where it is continuous with the anterior end of the body, and is somewhat spread out at its lower end so as to form a base of attachment; otherwise it is of much the same thickness throughout.

The branchial aperture is placed close to the anterior extremity, at the commencement of the dorsal edge and immediately below the peduncle (Pl. X. figs. 1 and 2). It is sessile but very conspicuous, and, as in the last species, is large, open, and triangular in shape—the base being anterior and the apex posterior. It has a smooth lip, bordered by a ridge, which, on the posterior side, is cut up into a series of blunt papillæ placed side by side. The branchial aperture looks almost directly anteriorly. The atrial aperture is at the opposite end, being placed in the centre of the large posterior extremity, and looks directly posteriorly. It is sessile, conspicuous, large, and open. It is bilabiate, and presents the form of a transverse slit, having smooth lips, and a conspicuous raised border on the ventral side (Pl. X. figs. 1 and 3).

The surface is very irregular. It is raised into prominent, rounded, pad-like, longitudinally running ridges, separated by deep creases. These ridges are again subdivided by slighter transverse creases into small irregularly-shaped elevated areas, each of which bears in its centre a small but prominent papilla, which may be sharp-pointed. Otherwise the surface of the body is perfectly smooth. The peduncle is finely grooved longitudinally throughout its length.

The colour of the body is a pale grey, having a bluish hyaline appearance in some parts, and a warmer yellowish tinge in others. The peduncle is rather bluer, being of a pale slate-grey throughout.

The dimensions are as follows:—

Length of the body (antero-posterior),	5 cm.
Breadth of the body (dorso-ventral),	4 „
Thickness of the body (lateral),	3·5 „
Length of the peduncle,	10·5 „
Thickness of the peduncle (average),	1·5 mm.

The Test is rather thick. It has a cartilaginous appearance, but is quite soft; it is,

however, stiff, and not flexible like that of *Culeolus murrayi.* The thickness varies considerably, being much greater on the longitudinal ridges than in the hollows between. Its external surface is perfectly smooth, except where it is raised up to form the pointed papillæ above described.

The test is quite opaque on account of its thickness; here and there, in the thinner parts, it has a hyaline translucent appearance. Over the whole surface minute, opaque, light brown dots are thickly scattered, and are especially numerous at the anterior end and round the base of the peduncle. A microscopical examination of thin sections shows that these dots are comparatively large chambers in the test in connection with the blood-vessels which will be described shortly. The inner surface of the test is smooth and glistening—as usual the mantle adheres to it.

In its minute structure this test corresponds closely to that of *Culeolus murrayi.* The chief difference lies in the disposition of the blood-vessels. In the present species they are greatly developed, the test being much more vascular than in the last species. In all the sections vessels were numerous, though most of them were of small size. They branch and anastomose, ramifying through all parts of the test, and ending frequently near the external surface in small rounded knobs. The finer vessels are peculiar on account of the great distances to which they extend, and their frequently zig-zag and cork-screw-like course (Pl. X. fig. 4). Here and there, in the deeper parts of the test, one comes across sections of the large trunks from which the smaller vessels arise, but these are rare. Large cavities or reservoirs are also met with, both in the deeper parts of the test, and, as in the last species, just under the external surface; but they are very rare. These cavities are usually filled with masses of reddish-brown blood-corpuscles (Pl. X. fig. 4, *b.c.*), and thus appear externally as the light brown dots mentioned above.

In the creases on the outside of the test there may be seen numbers of small delicate finger-like processes projecting beyond the surface, and in many cases these may be traced down for a short distance through the test (Pl. X. fig. 4, *t. p.*), and observed opening into one of the many fine vessels ramifying in the superficial layer. The finger-like processes are hollow, and extremely thin-walled; blood-corpuscles may be noticed here and there in their interior, and there can be no doubt that they correspond to the papillæ covering the external surface of the test in *Culeolus murrayi.* In the present case, besides being much fewer in number, they are far smaller, and their bases are not expanded to form large cavities as in the other species. In the other details of its minute structure, this test exactly resembles that of *Culeolus murrayi.*

The Mantle in this species is rather thin in relation to the size of the body. As in the last species, it adheres slightly to the inner surface of the test, but is easily detached.

The muscle bands are strong but distant. Most of them run transversely. A few, however, are longitudinal, and cross the first at right angles, so as to form a wide

rectangular network. Sphincters can scarcely be said to be present. In minute structure the mantle is precisely similar to that of the last species.

The Branchial Sac.—As the branchial sac is formed on the same plan as in *Culeolus murrayi* no detailed description is necessary. There are six longitudinal folds on each side, and they diminish in size from the dorsal to the ventral edge, those next the endostyle being very slight.

The transverse vessels are of three distinct sizes, and are arranged in the following manner (Pl. X. fig. 5):—Intermediate between every two of the largest (*tr.*) is a middle-sized one (*tr.'*) separated from each of the largest by three of the smallest size (*tr.''*) (see also fig. 14, p. 122) so that we have in series a large one, three small ones, a middle-sized one, three small ones, and a large one; consequently seven smaller transverse vessels are interposed between each pair of large ones.

Both transverse vessels and internal longitudinal bars are much closer than in *Culeolus murrayi*, and consequently the meshes are much smaller, usually one-eighth of the size; they are transversely elongated (Pl. X. fig. 5, and Pl. XIII. fig. 5), and their length is usually to their breadth about in the proportion of five to three.

The calcareous spicules in the vessels are much smaller and less branched than in *Culeolus murrayi*, but they are more numerous. They are especially plentiful in the internal longitudinal bars. The most common form is a simple elongated spindle, frequently bifurcated at one of the ends or having a branch from the middle so as to form a triradiate spicule.

The Endostyle is conspicuous, and has prominent lips as in the last species, but they are not white. Branched calcareous spicules are present in large numbers, but they do not form such dense masses along the sides, thus accounting for the want of whiteness in the lips. Along the edges, in the region occupied in *Culeolus murrayi* by the quadrate masses of spicules, are arranged a series of very large, branched, usually irregularly pinnate or fan-shaped spicules (Pl. XIII. fig. 6, *sp.*). Between these there are generally smaller and slighter spicules. From this point inwards to the centre of the endostyle, the spicules are numerous and of moderate size, generally having the branches longer and more slender than those in *Culeolus murrayi*. The central third of the organ is traversed by dark yellowish-brown longitudinal bands as in the last species; they represent prominent ridges of columnar epithelium. The very centre of the groove has a clear line down it, bounded on each side by a broad brown band (Pl. XIII. fig. 6, *c.b.a.*), outside of which, separated by slight intervals, are two narrow brown bands (*l.b.b.*).

The Dorsal Lamina is represented by a series of languets (Pl. X. fig. 6, *d.l.*). They are large, of an elongated triangular form, and are very closely placed.

The Tentacles are sixteen in number and are branched. They are of two sizes (Pl. X. fig. 6), and are placed large and small alternately. The tentacles in the two sets vary,

however, in size, and the large one situated close to the dorsal tubercle (*tn.*) is gigantic compared with the others. The ordinary large ones (*tn.'*) are about twice the breadth of the præbranchial zone, while the small ones are only one-fourth or one-third of that size. Calcareous spicules are present, but they are not so numerous as in *Culeolus murrayi.*

The Dorsal Tubercle is small, but distinct. It has a cordate form, with both horns turned inwards, and the opening directed towards the right side (Pl. X. fig. 6).

The Perituberculer Area is not so deep as in *Culeolus murrayi*, and has not such a regularly triangular form. Its depth is about equal to the breadth of the præbranchial zone on the right (or broader) side (Pl. X. fig. 6).

The Peripharyngeal Band at the edge of the perituberculer area extends further up on the left side than on the right, so as to narrow the præbranchial zone on that side.

There is only a single specimen of this handsome species in the collection. It is in most excellent condition, and was dredged in the South Pacific Ocean, to the north of the Kermadec Islands.

Station 170. July 14, 1874. Lat. 29° 45′ S., long. 178° 11′ W.; depth, 630 fathoms; bottom temperature, 4° C.; hard ground, volcanic mud, and pieces of pumice, &c.

Culeolus recumbens, Herdman (Pl. XI. figs. 1–7, and Pl. XII. figs. 1–7).

Culeolus recumbens, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880-81, p. 85.

External Appearance.—In this species the body is much smaller than in either of the preceding forms. Seen laterally (Pl. XI. figs. 1 and 2) its shape is irregularly quadrate with the angles rounded. It is elongated antero-posteriorly and rudely sub-cylindrical, being slightly compressed laterally. Both ends are blunt; the anterior is rather narrower than the posterior; and the posterior is the more convex of the two. The dorsal and ventral edges are nearly parallel, tapering slightly anteriorly; the dorsal is nearly straight, while the ventral is a little convex, especially towards the posterior end.

The peduncle is long, thin, and tough; it is not stiff, as in the last two species, but is very flexible, and in general appearance resembles a piece of thin string. It is attached at the anterior end of the body on the ventral side of the branchial aperture, and in the first part of its course it runs directly ventrally, so as to leave the branchial aperture exposed, instead of crossing it as in *Culeolus murrayi* and *Culeolus wyville-thomsoni.* This directly ventral course is, however, of very short extent (1–2 mm.), as it soon turns abruptly to the right and describes a nearly semicircular curve, and then leaves the surface of the test to which up to this point it has been closely adherent (Pl. XI. figs. 1 and 3). It is of uniform thickness throughout, except at the lower end, where for the last few millimetres it becomes slightly thickened, and then breaks up into a

mass of tangled filaments which have evidently been rooted in globigerina ooze (Pl. XI. figs. 1 and 2).

The branchial aperture is at the anterior end, terminal, and almost or quite median, being sometimes slightly dorsal. The insertion of the peduncle just at its ventral edge causes that point to be the most prominent part of the anterior end, and so to throw the branchial aperture a little dorsally. The aperture is sessile, conspicuous, and of considerable size. It has the form of a triangular slit (Pl. XI. fig. 3), elongated transversely, and having the apex directed dorsally. It has a raised lip all round, cut up into a series of blunt rounded papillæ placed closely side by side. The branchial aperture is directed either anteriorly or anteriorly and slightly dorsally.

The atrial aperture is not so far distant as in the two previously described species. It is situated at the junction of the dorsal edge with the dorsal extremity of the large curved posterior end, and looks dorsally and a little posteriorly. It is sessile but prominent, conspicuous, of moderate size, and slightly open. It has the form of a transversely elongated elliptical slit (Pl. XI. figs. 1, 2 and 4), with a raised lip on both edges, formed, like that round the branchial aperture, of a series of close-set blunt papillæ. This aperture is about two-thirds of the way from the branchial aperture to the middle of the posterior end.

The surface of the body is regular and even, and is pretty smooth. Here and there sprinkled over it there are slight papillæ and granulated patches. Round the posterior end, however, and enclosing the atrial aperture, there is a band of closely placed, slightly larger papillæ or processes, forming a structure like that seen in a similar position in *Culeolus murrayi*. It is quite a narrow band, but is continuous, and forms a ring cutting off obliquely about the posterior fourth of the body from the rest. Dorsally it skirts the anterior margin of the atrial aperture (Pl. XI. figs. 1, 2 and 4), while its ventral part separates the posterior end from the ventral edge of the body, or may lie even more posteriorly, so that its direction, viewed laterally, is from the dorsal edge ventrally and posteriorly.

The colour of the body is a pale grey, in some places having a yellowish-white appearance. The peduncle is yellowish-white or of a dirty cream colour.

The dimensions are as follows:—

Length of the body (antero-posterior),	2·5 cm.
Breadth of the body (dorso-ventral),	1·7 „
Thickness of the body (lateral),	1·5 „
Length of the peduncle,	14 „
Thickness of the peduncle,	1 mm.

The Test is thin and flexible, but tough. It is almost opaque, being only semi-transparent in parts. The outer surface is rough and irregular, and is considerably coated with Foraminifera, sand-grains, mud, &c.

In minute structure it is very compact (Pl. XII. fig. 1). The matrix is close and

homogeneous, and contains only small rounded protoplasts. In several sections examined no vessels were found; so that, if they are present in this test, they must be few in number.

Sections through the peduncle (Pl. XII. fig. 2) show it to have a structure very similar to that of *Culeolus murrayi*. The matrix is like that of the test covering the body, and contains similar minute rounded protoplasts. It is perforated by several large holes (Pl. XII. *ped. c.*), the sections of large tubes running longitudinally along the peduncle, and each of them containing a large blood-vessel in its interior.

The outer surface of the peduncle has adhering to it a considerable quantity of sand-grains, Foraminifera, shell fragments, &c., and in the sections one finds similar particles imbedded in the matrix often far distant from the surface (Pl. XII. figs. 1 and 2). These have doubtless become surrounded by the outward growth of the peduncle.

The Mantle is very thin, and has the form of a delicate membrane adhering closely to the inner surface of the test, from which it is separated with difficulty. The musculature is feeble, consisting of a series of distant transverse bands crossed by slighter and more irregular longitudinal bands.

The Branchial Sac is a coarse network—the vessels being strong for the size of the body. There are several longitudinal folds on each side of the sac, but they are very slight. The internal longitudinal bars are wide and prominent. They are regularly placed, and are apparently the strongest part of the network. The transverse vessels are all of the same size, but they are irregular, and are much slighter than the internal longitudinal bars. Usually the meshes are rather large and are elongated longitudinally (Pl. XI. fig. 5, and Pl. XII. fig. 3)—the breadth being about three-fourths of the length, but occasionally irregularly placed intermediate transverse vessels (Pl. XI. fig. 5, *tr'.*) are present, and sometimes oblique or longitudinal vessels (*l.v.*), usually of small calibre, are given off from the transverse vessels, thus breaking the mesh up into compartments, and suggesting the formation of true stigmata.

The calcareous spicules are not at all prominent, on account of their small size, but they are pretty numerous, and often ramify considerably (Pl. XI. fig. 5, and Pl. XII. fig. 3, *sp.*). They are mostly more branched and more irregular than those of either *Culeolus murrayi* or *Culeolus wyville-thomsoni*. As usual they are present chiefly in the internal longitudinal bars.

The Endostyle is broad and distinct. The prominent edges have a creamy white tint, while the groove is brown (Pl. XII. fig. 4).

Calcareous spicules are not present in such numbers as in either of the preceding species. The raised edges (*w.e.*) in which they are situated are semi-transparent, and each equals in breadth about one-fifth of the breadth of the entire organ. The spicules are large and considerably branched but are not numerous. They resemble those of the central part of the endostyle of *Culeolus murrayi*.

Inside each edge is an opaque brown area of about the same breadth as the edge (*l.b.b.*),

and divided into an outer broad lighter, and an inner narrow darker band formed of closely packed columnar cells (Pl. XII. fig. 5). Between the two opaque brown areas lies the central fifth, which is semi-transparent but darker than the raised edge. Neither the opaque brown areas nor the central clearer part contain spicules.

The Dorsal Lamina is replaced by a series of large triangular languets. They are not broad at the base, and taper gradually to a blunt point. They are moderately closely placed, there being about two to each mesh—one opposite each transverse vessel and one between each pair.

The Tentacles are branched and are very long. There are about twenty-four of them, and they are of two sizes, placed alternately. They are more branched and larger in comparison to the size of the body than in either of the preceding species. One of the ordinary large tentacles measures about 9 mm. in length. Ramifying calcareous spicules are present here and there, but they are not at all numerous.

The Dorsal Tubercle is of small size and is ellipsoidal in form, having no aperture, and consequently no horns (Pl. XI. fig. 6, *d.t.*). It lies near the posterior angle of the large triangular peritubercular area, and is immediately below the nerve ganglion, being situated at the right side of its anterior end.

The peritubercular area is large and of an irregularly triangular form. It is not, however, very deep, being broad at the anterior end. The peripharyngeal bands are narrow and undulated. As in the last species the band extends further forwards on the left side of the peritubercular area than on the right (Pl. XI. fig. 6, *p.p.*).

The Nerve Ganglion is of considerable size, and much elongated antero-posteriorly. It is narrow and of much the same calibre throughout, swelling slightly in its atrial half. It lies with its middle point placed about the apex of the peritubercular area (Pl. XI. fig. 6). The branchial end divides into two divergent nerves (*br.n.*), at the origin of one of which (the right) the dorsal tubercle is situated. The atrial end of the ganglion gives off four nerve trunks, two posteriorly side by side (*at.n.*) and two laterally at right angles to the axis of the ganglion, one to each side. The left one soon subdivides into two branches.

The Alimentary Canal.—The œsophageal opening (Pl. XI. fig. 7, *œ.*) is at the posterior end of the branchial sac, and the œsophagus is a short round tube running ventrally and anteriorly to enter the large stomach (*st.*) which lies along the left side of the ventral edge of the branchial sac. Like the stomach in *Culeolus murrayi* it is very irregular. It has three prominent lobes or pouches, each of which ends in a large number of small papilla-like processes. The intestine emerges from the anterior narrower end of the stomach, and continues its direction forwards on the left side of the branchial sac, and then curves round in a wide loop dorsally, and runs posteriorly as far as the level of the intestinal end of the stomach, and there ends in the anus (*a.*) which has its margin cut into a papillary fringe.

Genitalia.—There are three genital glands on each side adhering to the inner surface of the mantle. They are of an elongated pyriform shape, and have moderately long ducts attached to them (Pl. XI. fig. 7, *g.*).

The three on the left side lie in the intestinal loop and close to the ventral side of the rectum or terminal part. They are placed with their long axes dorso-ventrally and are in a row, one being anterior, one posterior, and one in the middle. The posterior one is in a line with the anus towards which the ducts of all three converge. The duct of the anterior gland is about three times as long as that of the posterior one, while the middle one has a duct of intermediate length.

The three glands on the right side are more closely placed than those on the left. They lie on the inner surface of the mantle about half-way between the atrial aperture and the stomach, with their ducts directed towards the atrial aperture and their sides touching. The ducts of all three are of much the same length.

Each gland is a pyriform mass containing ova and spermaria, and the duct is double, consisting of a shorter and wider oviduct, and a longer and narrower vas deferens which runs alongside the oviduct but projects beyond it.

There are eight specimens of this species. They were all taken in the Southern Ocean, about half-way between the Cape of Good Hope and Kerguelen Island.

Station 146. December 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E.; depth, 1375 fathoms; bottom temperature 1°·5 C.; globigerina ooze.

Culeolus perlucidus, Herdman (Pl. XI. figs. 10–14, and Pl. XII. figs. 8–12).

Culeolus perlucidus, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 86.

External Appearance.—In this species the body and stalk have much the same proportions as in *Culeolus recumbens.* The shape of the body is somewhat ovate or pyriform, gracefully curved, and scarcely compressed laterally (Pl. XI. fig. 10). The anterior end, where the body becomes continuous with the stalk, is produced and tapering, while the posterior end is rounded and broader, though it is by no means the widest part of the body. The dorsal edge is slightly convex forming a gentle curve, but the ventral is extremely convex, especially at the anterior end, where it rises from the narrow extremity in a bold curve, which attains its greatest height at about one-third of the way to the posterior end. The two sides are equally convex.

The peduncle is long and thin, flexible, but stiffer than that of *Culeolus recumbens.* It is perfectly transparent and looks like a delicate glass spine. It is attached to the anterior end of the body, at some distance from the branchial aperture, and is bent at a right angle at the point of attachment, so that it runs ventrally and describes a gentle curve towards the posterior end. From the anterior end it is continued, attached to the test, along the dorsal edge fully half-way to the branchial aperture (Pl. XI. fig. 10).

This upper extremity and the base are slightly enlarged, otherwise the peduncle is of the same thickness throughout.

The branchial aperture is situated on the dorsal edge near the anterior end, and about one-fourth of the distance from the point of attachment of the peduncle to the posterior end. It is very conspicuous, and projects slightly from the surface of the test. It has the form of a transverse slit, large and open, and having its posterior edge arched so as to form an approach to the triangular outline seen in the preceding species. The lips are large and prominent, especially the posterior one, but smooth; no papillary fringe is present. The branchial aperture is directed anteriorly and slightly dorsally (Pl. XI. fig. 10).

The atrial aperture is not very distant from the branchial, being situated at the junction of the dorsal edge with the rounded posterior end, and is directed dorsally and posteriorly. It is conspicuous, but not so prominent as the branchial aperture, is of moderate size, and gapes slightly. It has the form of a transverse slit bounded by raised anterior and posterior lips which are both smooth.

The surface is regular, but finely granular from the presence of minute processes all over, except on the lips of the apertures which are perfectly smooth. The surface of the peduncle and its continuation along the dorsal edge are also smooth.

The colour is a light grey, with a translucent appearance. The peduncle is hyaline and transparent.

The dimensions are as follows:—

Length of the body (antero-posterior),	2	cm.
Breadth of the body (dorso-ventral),	1.4	„
Thickness of the body (lateral),	1·3	„
Length of the peduncle,	about 11	„
Thickness of the peduncle,	7	mm.

The Test, like that of *Culeolus recumbens*, is thin and flexible, but tough. Unlike it, however, it is transparent. It is very compact, and in minute structure resembles that of the last species. The matrix is very close and homogeneous, and contains only rounded and elongated protoplasts, generally arranged parallel to the surface. In the sections examined no vessels were present, but every here and there along the inner surface small pouches or excavations in the matrix were discovered containing blood-corpuscles (Pl. XII. fig. 8, *v.*). These are doubtless diverticula from the sinuses of the mantle.

The outer surface is rough from the presence of minute processes rising occasionally into small papillæ which may equal the thickness of the test in height (Pl. XII. fig. 8, *t.p.*). These have generally sand-grains and minute particles of mud adhering to them, but the general surface is not coated as in the preceding species.

The peduncle is hollow. It is a thin-walled tube, the thickness of the wall being only about one-sixth of the total diameter. The interior of the tube is lined by a membrane formed of tesselated epithelial cells, diamond-shaped or short fusiform, and

distinctly nucleated, closely resembling the epithelial lining of the blood-vessels in the peduncle of *Culeolus murrayi*. No blood-corpuscles were noticed in the interior of this tube, but there can be little doubt that it is a great sinus in connection with the blood-vessels of the mantle.

The wall of the tube has the same structure as the test over the body, and has no vessels in it. The outer surface is very smooth, and has no foreign matter adhering or imbedded as in the last species.

The Mantle is a very delicate membrane which does not adhere closely to the test as in *Culeolus recumbens*, but is easily separated. The musculature is feeble, and consists, as in the last species, of intersecting bands of fibres. The network formed, however, is very irregular, as the bands are not arranged in parallel series.

The Branchial Sac is more delicate than that of *Culeolus recumbens*. As in that species there are several longitudinal folds on each side of the sac, but they are very slight, being of the simplest form possible—merely a second internal longitudinal bar attached to each of the normal ones by a short connecting piece at each transverse vessel (Pl. XI. fig. 11, *br.f.*). These secondary internal longitudinal bars, representing the folds, project into the interior of the cavity. The transverse vessels are moderately wide, all of one size, and placed distantly. Occasionally, however, much slighter intermediate transverse vessels are present (Pl. XI. fig. 11, *tr.'*), dividing the meshes.

The meshes formed by the intersection of the large transverse vessels and the internal longitudinal bars are nearly square, the antero-posterior extent being generally slightly the greater. Each mesh is divided into two by a delicate longitudinal vessel running from each transverse vessel to the next, and placed about midway between the two internal longitudinal bars (Pl. XI. fig. 11, *l.v.*), so that, going round the sac dorso-ventrally, one comes upon two internal longitudinal bars united to form a fold, a narrow longitudinal vessel uniting the transverse vessels, and then other two internal longitudinal bars, and so on. These narrow longitudinal vessels springing from the transverse vessels are of course homologous with the fine interstigmatic vessels of most branchial sacs, so that in the present species the mesh might be correctly described as containing two stigmata.

In the portions of the branchial sac examined, no calcareous spicula were detected; but as in some of the other species the spicules were absent over considerable areas, and as they are sometimes very small and difficult to distinguish, I prefer to think that spicules, though doubtless few and minute, are probably present in this species, than to suppose that it differs from all the other species of the genus, which it otherwise so closely resembles, in this important particular.

The Endostyle.—This organ is narrow, and not nearly so conspicuous as in *Culeolus recumbens*. The most striking peculiarity, however, is that no calcareous spicules can be detected in any part of it.

As in all the preceding species of *Culeolus*, there is a clear edge on each side, and a

central area traversed by longitudinal opaque brown bands (Pl. XII. fig. 9). The clear edge (*w.e.*), usually so abundantly provided with spicules and forming such a favourable locality for observing them on account of its transparency, exhibits no trace of them whatever. It is on each side fully a quarter of the total breadth of the organ, and is covered with squamous epithelium. The edge is bounded internally by an opaque brown band (*l.b.b.*) of moderate breadth. This, the lateral band, is separated from the central brown area by a clear space of moderate breadth. The central area (*c.b.a.*) has a median broad dark brown band running down the centre and in places traversed by a central fine clear line. This broad band is separated by a narrow clear space from a narrow very dark brown band on each side. These narrow bands bounding the central area, are a little irregular in their course.

The Dorsal Lamina is represented as usual by a series of languets. They are triangular in form, rather wide at the base and tapering to a point. They are rather closely placed.

The Tentacles are numerous. A few of them are much larger than the others, being of considerable size, and are much branched (Pl. XII. fig. 10, *tn.*). The remainder are all much smaller, but are of various sizes (*tn.′ tn.″*), and have apparently no definite arrangement.

The Dorsal Tubercle lies near the posterior end of the large and very irregular peritubercular area (Pl. XI. fig. 12). It has the form of a short sugar-loaf, the base or open (?) end being posterior and turned towards the right side, while the pointed end is directed anteriorly and to the left, and seems to be in direct connection with the anterior extremity of the nervous mass. The peritubercular area is large and wide; its breadth at the mouth is fully greater than its depth.

The Peripharyngeal Bands are narrow but distinct. Where they bound the sides of the peritubercular area they have a very irregular course (Pl. XI. fig. 12, *p.p.*), undulating and forming sharp folds, so as to give the generally triangular peritubercular area a very complicated outline.

The Nerve Ganglion lies at the apex of the peritubercular area (Pl. XI. fig. 12, *n.g.*). It is much shorter than in *Culeolus recumbens* and has an oblong form, narrowed slightly towards the ends. The posterior extremity splits into two large nerve trunks, while the anterior is hidden in the pointed extremity of the dorsal tubercle.

The Alimentary Canal lies on the left side of the branchial sac. The œsophagus is very short and passes over imperceptibly into the large stomach (Pl. XI. fig. 13, *st.*), which is a long irregularly fusiform body with no cæcal processes as in *Culeolus murrayi* and *Culeolus recumbens.* The intestine, after emerging from the stomach, continues its direction for a short distance, and then turns in a wide loop and runs back parallel to the stomach, with the edge of which it is in connection, passes close to the œsophageal aperture, and, curving up dorsally, ends close to the

atrial aperture (Pl. XI. fig. 13, *a.*). The long axis of the stomach and of the greater part of the intestine lies antero-posteriorly.

Genitalia.—There is a single large genital gland on the inner surface of the mantle on each side. Both are of pyriform shape and have short ducts directed towards the atrial aperture (Pl. XI. fig. 13).

The gland on the left side is the larger of the two. It lies alongside the intestine, not in the loop, and has its long axis parallel to that of the stomach. The gland on the right side is considerably shorter than the other. The aperture of its duct is not far from the anus (Pl. XI. fig. 13).

Each of the glands contains both masses of ova and spermaria arranged so as to form the wall of a large cavity which occupies the interior of the pyriform mass (Pl. XII. fig. 11). From sections of the gland one learns that the spermaria are arranged along the outer surface and form a compact layer (Pl. XII. fig. 11, *t.v.*), while the ova (*o.*) occupy the inner part next the central cavity, into which they project irregularly.

The ducts from the glands are short and consist of a closely applied oviduct and vas deferens, the former being the wider, and the latter slightly the longer of the two.

There are three specimens of this species, two of which were more or less injured. They were obtained in the Southern Ocean between the Cape of Good Hope and Kerguelen Island.

Station 147. December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; depth, 1600 fathoms; bottom temperature, 0°.8 C.; globigerina ooze.

Culeolus perlatus, Suhm (sp.) (Pl. XI. figs. 8 and 9, and Pl. XIII. figs. 1 and 2).

Boltenia perlata, Suhm, MS., 1873.

Culeolus suhmi, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880–81, p. 86.

External Appearance.—This is the smallest of the six species, and it has much the shortest stalk. The general form of the body is between ovate and wedge-shaped, the anterior end being very narrow, and the posterior much wider (Pl. XI. fig. 8). The form is most definite and the outline regular; there is no lateral compression. The anterior end is narrow but not so produced as in the last species. The posterior end is broad but not rounded. It is an oblique line sloping backwards to form an angle with the end of the ventral edge, and dorsally becoming continuous by a gentle curve with the dorsal edge. The two edges are very different. The dorsal is strongly convex, rising suddenly behind the branchial aperture, and attaining its greatest height at about one-third of the distance to the posterior end; the ventral edge, on the other hand, is almost straight, forming a long low arch from the end of the peduncle anteriorly to the line of junction with the posterior end. The two sides are equally curved.

The peduncle is not long and is rather thin, but stiff (Pl. XI. fig. 8). It is attached to the anterior end of the body, and continues the line of the ventral edge. It turns dorsally at a right angle and its course is straight as a whole, although it makes one or

two slight undulations. From its point of attachment it is traceable for a short distance along the ventral edge, imbedded in the test. The upper and the lower ends are both thickened, elsewhere it is of uniform thickness.

The branchial aperture is large, prominent, and very conspicuous. It is situated at the anterior end and is terminal and median, being directly under the curve of the peduncle (Pl. XI. fig. 8). It has the form of a long transverse slit, gaping considerably, and bounded by prominent, smooth, dorsal and ventral lips. It looks directly anteriorly.

The atrial aperture is situated at the posterior extremity of the dorsal edge, just where it passes over into the posterior end. It is sessile, but large and conspicuous, and has the form of a transverse elliptical slit gaping slightly and bordered by smooth anterior and posterior lips. It is directed dorsally and slightly posteriorly.

The surface is regular, but rough all over from the presence of minute pointed papillæ. Surrounding the atrial aperture, and cutting off about a third of the body, is a band of slightly larger papillæ forming a ridge like those already described in *Culeolus murrayi* and *Culeolus recumbens*. In this species the band is not broad but is compact and continuous, and of the same breadth throughout its course (Pl. XI. fig. 8). It runs from the sharp angle formed by the junction of the ventral edge and the posterior end across the side of the test in a slightly undulating course to cut the dorsal edge at the highest point in its curve, about one-third of the distance from the anterior to the posterior end. It runs therefore from the most posterior point of the body anteriorly and dorsally. The surface of the peduncle is slightly roughened, but it has no sharp papillæ.

The general colour of both body and peduncle is an earthy brown. Closer examination shows that the ground colour of the test is really much lighter, being a pale greyish brown, and that the darker effect is due to the presence of the numerous fine papillæ which are of a very dark brown.

The dimensions are as follows :—

Length of the body (antero-posterior), ...	8 mm.
Breadth of the body (dorso-ventral), ...	5·5 „
Thickness of the body (lateral), ...	5 „
Length of the peduncle, ...	5 cm.
Thickness of the peduncle, ...	·5 mm.

The Test is thin, but tough and rather stiff. It is quite opaque. Its outer surface is very rough from the presence of a great number of minute, closely placed, dome-shaped, or pointed papillæ, which are scattered all over it. Each of these papillæ stands in a little area of the test separated off by a slight ridge, and the papillæ are so closely placed that these ridges divide the entire surface of the test into diamond-shaped, hexagonal, or polygonal areas (Pl. XIII. fig. 2). These ridges, as well as the papillæ, are of a blackish brown colour, while the tint of the remainder of the test is much lighter. There is no foreign matter adhering to the surface of the test.

The surface of the peduncle is slightly uneven, and examination under a low power of

the microscope reveals that this is due to the presence in the interior of a number of trabeculæ, which form a close network and cause projections on the surface from the sinking in of the matrix over the meshes (Pl. XIII. fig. 1). The trabeculæ (*t.m.c.*) are of a rich brown colour, and stand out from the surrounding material (*t.m.*), which is much paler and less opaque. Probably these trabeculæ are of the same nature as the cornified bars of test matrix separating the blood channels in the peduncle of *Culeolus murrayi.*

The Mantle is a very delicate membrane, and the musculature is feebly developed.

The Branchial Sac is very delicate and has several slight folds on each side. These are formed in the usual manner, and each has about four internal longitudinal bars (Pl. XI. fig. 9, *br.f.*). The transverse vessels are narrow and are all of one size. The internal longitudinal bars are wider, forming the strongest part of the network.

The meshes are large and are nearly square, usually a little elongated transversely (Pl. XI. fig. 9); in the row on each side of the dorsal lamina they are more elongated, the transverse extent being to the longitudinal in the proportion of six or seven to four; no secondary transverse vessels, fine longitudinal vessels, or other irregularities were observed.

Calcareous spicules are present in the internal longitudinal bars. They are not very numerous but are large and branched slightly, resembling those of the branchial sac of *Culeolus murrayi.*

The Dorsal Lamina.—The languets placed along the dorsal line are large and triangular, but rather broader and blunter than usual.

The Tentacles are branched, and are large compared to the size of the body. They are sixteen in number, and are of two sizes placed long and short alternately.

They are not much branched, and contain numerous and large calcareous spicules of the same form as those in the branchial sac. The branches are rather long and narrow.

A single specimen of this small species, slightly injured, was obtained off the east coast of North America, south from Long Island. After the publication of the part of my Preliminary Report in which this species was described as new under the name of *Culeolus suhmi*, a MS. of Dr. R. von Willemœs Suhm was placed in my hands, in which a sketch and a brief description, under the name of *Boltenia perlata*, n. sp., evidently refer to this specimen. I have consequently substituted Suhm's specific name.

Station 44. May 2, 1873; lat. 37° 25′ N., long. 71° 40′ W.; depth, 1700 fathoms; bottom temperature, 1°·7 C.; grey ooze (a blue mud).

Culeolus moseleyi, Herdman (Pl. X. figs. 7-12 and Pl. XIII. figs. 3-4).

Culeolus moseleyi, Herdman, Preliminary Report, Proc. Roy. Soc. Edin., 1880-81, p. 87.

External Appearance.—This is a small species, but it has the body and the peduncle both rather elongated. The general outline of the body is elongated pyriform, the anterior being the narrower tapering end (Pl. X. fig. 7). The outline is pretty regular, and

the body is somewhat compressed laterally. The anterior extremity is very narrow and attenuated, being more produced, and tapering more gradually than in any of the other species. The posterior end is broad and slightly rounded, having a truncated appearance. It forms a nearly straight line dorso-ventrally, and curves round sharply at the ends to become continuous with the dorsal and ventral edges. These two edges are almost equally curved. They diverge from the narrow anterior end for about half the length of the body, at which point the greatest breadth (dorso-ventral) is attained. They then run parallel for a short distance, and finally curve sharply and evenly into the ends of the posterior extremity. The two sides are equally, but slightly convex.

The peduncle is rather long and thin, but stiff (Pl. X. fig. 7). It is attached to the attenuated anterior end of the body, and forms a continuous line with the dorsal and ventral edges. It may be traced for a short distance along the ventral edge, partly imbedded in the test. After leaving the test it runs for a short distance anteriorly, and then curves round dorsally at nearly a right angle, and preserves a slightly undulated course down to the base of attachment. At this point it is slightly expanded, elsewhere it is of the same thickness throughout.

The branchial aperture (Pl. X. fig. 7) is situated on the dorsal edge of the anterior end, and is nearly one-fourth of the length of the body, from the point of attachment of the peduncle. It is conspicuous but not prominent. It has the form of a transversely elongated rather crescentic slit, having the concavity directed posteriorly (Pl. X. fig. 8), and its anterior edge forming an angle in the middle so as to give the aperture a sub-triangular form like that of *Culeolus recumbens*. The anterior and posterior lips are not prominent and are scarcely marked. The opening is directed dorsally and anteriorly.

The atrial aperture lies in the centre of the large posterior end, and looks directly posteriorly (Pl. X. fig. 7). It is sessile but conspicuous, and is a large transverse, slightly crescentic, slit, gaping slightly, and having no raised lips (Pl. X. fig. 9). The edges are dorsal and ventral.

The surface is even but very rough, being covered all over with conical and dome-shaped papillæ (Pl. X. figs. 7, 8 and 9). These papillæ are larger than those scattered over the test in any of the other species, but here they are not modified in any particular region to form a band round the atrial aperture as in *Culeolus murrayi*, *Culeolus recumbens*, and *Culeolus perlatus*. The surface of the peduncle is slightly roughened like that of the last species.

The colour of the body is a pale yellowish-grey—the papillæ having a decided yellow tinge. The peduncle is darker, being of a greyish-brown colour.

The dimensions are as follows :—

Length of the body (antero-posterior),	2	cm.
Breadth of the body (dorso-ventral),	1·2	„
Thickness of the body (lateral),	8	mm.
Length of the peduncle,	about 9	cm.
Thickness of the peduncle,	·75	mm.

The Test is rather stiff and thick—thicker than in the three last described species. It is quite opaque. The outer surface is very rough, the papillæ being larger than and nearly as numerous as in *Culeolus perlatus*. They are dome-shaped, or of a short conical form.

The test between the papillæ has a yellowish-grey tint, in some places hyaline, while the papillæ are of an opaque yellow, thus adding greatly to the general yellow effect and opacity of the body. There is no foreign matter adhering to the surface.

The surface of the peduncle is slightly uneven from the same cause as in the last species. In this case, however, the trabeculæ are fewer in number, consequently the meshes are much larger and are more irregular (Pl. X. fig. 10). The dark brown trabeculæ are distinctly visible to the eye, and the matrix between them is of a bluish-grey colour, and semi-transparent.

The Mantle is thin, but the musculature is stronger than in the last three species. The muscle bands are strong, and in some parts are distant, while in others they are closely placed, forming a strong, but generally irregular, network.

The Branchial Sac is delicate, and has several slight folds on each side. They are similar to those in *Culeolus perlatus*, each having four or five internal longitudinal bars, which, however, are rather more closely placed (Pl. X. fig. 11, *br.f.*).

The transverse vessels are narrow and are all of the same size. The internal longitudinal bars are wider, and, as in the last species, form the strongest part of the network.

The meshes are square and are moderately large. Here and there secondary slighter transverse vessels and fine longitudinal vessels (Pl. X. fig. 11, *l.v.*) may be seen crossing the meshes, but they are rare.

Calcareous spicules are present in the vessels as usual, chiefly in the internal longitudinal bars. They are large and branched like those in the last species, and are numerous.

The Endostyle.—This organ, as usual, may be divided into an outer clear edge on each side, and a central, more opaque area (Pl. XIII. fig. 3). The edge (*w.e.*) on each side occupies about one-fourth of the entire width of the endostyle, and is transparent and covered by a layer of tesselated epithelium distinctly nucleated. This edge is bounded internally by a rather broad opaque yellowish-brown band (*l.b.b.*), which is separated by a narrow clear area from a slightly broader but similar band (*c.b.a.*), divided from its fellow of the opposite side by a narrow clear stripe. Consequently the central area is traversed by four broad bands running longitudinally, and separated by narrow clear stripes. Calcareous spicules are plentiful, and are scattered over the entire breadth of the organ, being present, however, in rather greater quantity in the central area than in the clear edges. They are large and considerably branched (Pl. XIII. fig. 3, *sp.*).

The Dorsal Lamina.—As usual, this is represented by a series of triangular languets. They are rather small and pointed.

The Tentacles are small, and seem not to differ strikingly in size. They are very delicate, and are very slightly branched, almost simple, having only occasional minute pinnæ. Calcareous spicules similar to those of the branchial sac are plentiful in the tentacles.

The Dorsal Tubercle is rather large, and has more of the usual appearance than those of *Culeolus recumbens* and *Culeolus perlucidus*. It is of a transversely ovate shape, with the aperture turned towards the right side (Pl. X. fig. 12). The anterior horn turns outwards and upwards, while the posterior horn, also turned outwards, is coiled in a close spiral of one and a half turns. The peritubercular area is triangular and not large in comparison with the size of the tubercle. The peripharyngeal bands forming its lateral boundaries are straight (Pl. X. fig. 12, *p.p.*).

The Nerve Ganglion.—The ganglion is large and of a bright yellow colour. It has an oblong quadrangular shape (Pl. XIII. fig. 4, *n.g.*), and gives off two large nerve trunks at each end.

In the mantle covering the ganglion dorsally, there is a patch of branched calcareous spicules, similar to those in the branchial sac. They are very numerous, and cross and interlace, forming in one part of the patch a very dense reticulum (Pl. XIII. fig. 4, *sp.*).

The single specimen of this species is in a good state of preservation. It was obtained in the centre of the Pacific Ocean, almost on the Equator.

Station 271. September 6, 1875; lat. 0° 33′ S., long. 151° 34′ W.; depth, 2425 fathoms; bottom temperature, 1° C.; globigerina ooze.

Comparison of the Species of Culeolus.

As the six species of this genus differ in nearly all the minute details of structure, it will be interesting to go over the more important organs, and point out the differences and resemblances which they present in the different species.

External Appearance.—In respect to external appearance there is a strong general resemblance between the species. They all consist of a more or less ovate body borne on a long peduncle. In all, the anterior end of the body, where the peduncle is attached, is narrower than the posterior end, and in none of them is there much lateral compression.

In all the species the peduncle, after leaving the test, turns at a right angle—in two of them (*Culeolus recumbens* and *Culeolus perlucidus*) ventrally, and in the other four dorsally. Consequently, in all the long or antero-posterior axis lies at right angles to the peduncle, and therefore in a more or less horizontal position. In *Culeolus wyville-thomsoni*, and *Culeolus perlucidus* this axis comes to be inclined downwards and posteriorly on account of the curvature of the peduncle, while in *Culeolus recumbens* the peduncle is so flexible that it could not have supported the weight of the body, which must, therefore, have rested on the bottom.

In the two larger species (*Culeolus wyville-thomsoni* and *Culeolus murrayi*) the branchial aperture has a clearly-defined triangular form, with the apex of the triangle directed posteriorly. In the other four species the shape is more that of a transverse slit, but there is a tendency in all of them towards a triangular form. This is most clearly seen in *Culeolus recumbens*, where the anterior or ventral lip is straight, while the posterior or dorsal is strongly arched, forming an angle in the middle, and in *Culeolus moseleyi* where the slit is crescentic—the apex here, however, being anterior.

In all the species the branchial aperture is situated on the dorsal side of the point of attachment of the peduncle, and consequently in the four species in which the peduncle turns dorsally the branchial aperture is to a certain extent hidden by it and looks more or less downwards towards the bottom; in *Culeolus perlucidus*, on the contrary, it is directed upwards.

The atrial aperture is a transverse bilabiate slit in all, and is situated towards the posterior end. In three species, *Culeolus murrayi*, *Culeolus wyville-thomsoni*, and *Culeolus moseleyi*, it is quite posterior, while in the other three it is a little dorsal in position.

In *Culeolus wyville-thomsoni*, the surface, though very uneven, is to the eye smooth; in the other species, however, it is rough from the presence of papillæ or tufts projecting from the surface of the test. In *Culeolus perlucidus* these are few in number and of small size, but in the other four species they are larger, and in three of them, *Culeolus murrayi*, *Culeolus recumbens*, and *Culeolus perlatus*, they are especially developed along a line round the posterior end and surrounding the atrial aperture. Along this tract the papillæ are larger and more closely placed, so as to form a continuous band. *Culeolus moseleyi*, finally, has the surface closely covered with papillæ of moderate size, making it equally rough all over.

Culeolus recumbens is the only species which has sand-grains and other foreign matter adhering to the surface of the body and peduncle, and it may be accounted for in this case by the position the body must have had, lying on the bottom on account of the weakness of the peduncle.

The peduncle in all the species is thin but tough, smooth, and somewhat flexible though stiffish, except in the case of *Culeolus recumbens*, where, as above mentioned, it is weak and very flexible like a piece of string. In all, it is expanded slightly at the lower end to form a base of attachment.

The Test.—In all the species the test is of a cartilaginous consistency, though, in some of them, especially *Culeolus recumbens* and *Culeolus perlucidus*, it becomes membranous, on account of its thinness.

The only notable peculiarities are in regard to the development and disposition of the blood-vessels. In *Culeolus murrayi* they are feebly developed throughout the thickness of the test, but as compensation they expand at the outer surface into large closely placed thin-walled chambers in communication with the large membranous hollow papillæ. In *Culeolus wyville-thomsoni*, on the other hand, vessels are numerous throughout the thick

test, and terminal expansions on the outer surface are very rare. In different parts of the test, however, usually deeply situated, there are large cavities or reservoirs full of yellowish-brown blood-corpuscles, and appearing to the eye as minute brown dots scattered thickly over the test. In these species there are also found, in connection with the terminal twigs of the vessels in the superficial layer, numbers of minute thin-walled finger-like processes projecting beyond the surface of the test. They are found in the hollows and grooves on the uneven surface, probably on account of the protection afforded to them in these spots. These delicate processes doubtless represent the papillæ of *Culeolus murrayi.*

In *Culeolus perlucidus,* the pouches or cavities filled with blood-corpuscles seen on the inner surface of the test are undoubtedly prolongations from the blood-sinuses of the mantle. No further development of the vascular system in the test was seen either in this species or in *Culeolus recumbens.* In *Culeolus moseleyi* and *Culeolus perlatus,* of each of which there are only single specimens, the test could not be examined.

The peduncle probably contains blood-vessels in all the species. In *Culeolus murrayi* and *Culeolus recumbens* the vessels are numerous, and form a network traversing the peduncle. In *Culeolus perlucidus* there is a single central canal, apparently vascular. In the remaining three species the peduncle could not be examined without injuring the single specimens. In two of them, *Culeolus moseleyi* and *Culeolus perlatus,* a network of brown bars is distinctly visible from the exterior traversing the substance of the peduncle. These bars possibly indicate thickened or modified portions of the matrix separating canals in which the blood-vessels lie, as seen in *Culeolus murrayi.*

The structure of the mantle is very similar in the six species.

The Branchial Sac.—This is much the most characteristic organ in the genus, and is very similar in all the species.

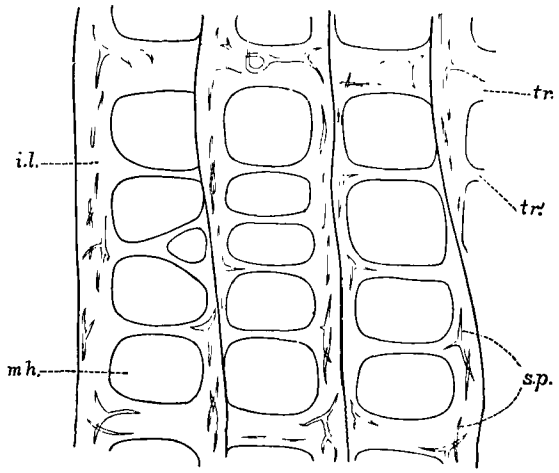


FIG. 14.—Part of the Branchial Sac of *Culeolus wyville-thomsoni,* from the inside.
tr., large transverse vessel; *tr'.*, smallest size of transverse vessel; *i. l.*, internal longitudinal bar; *mh.*, mesh; *sp.*, spicula.

The arrangement found in *Culeolus wyville-thomsoni* is perhaps the most distinct. Here the meshes are much smaller than in any of the other species, and three distinct sizes of transverse vessels are present (fig. 14). In *Culeolus murrayi* there are two sizes, arranged alternately. In the other four species the transverse vessels are apparently all of equal calibre.

The number of folds in the branchial sac was only determined in two of the species, *Culeolus murrayi* and *Culeolus wyville-thomsoni*, and in both it was six on each side. In the other species there are several folds on each side, probably six also. The simplest form of fold is that seen in *Culeolus perlucidus*, where it consists merely of one additional bar running parallel with and attached to each internal longitudinal bar on its inner surface. The irregular secondary transverse vessels and fine longitudinal vessels found occasionally in *Culeolus recumbens* and *Culeolus moseleyi* are very interesting as showing a tendency towards the formation of stigmata. This process has gone further in *Culeolus perlucidus*, where the fine longitudinal vessels intermediate to the internal longitudinal bars divide the meshes into spaces comparable with true stigmata.

With regard to the apparent absence of spicules in the branchial sac and endostyle of *Culeolus perlucidus*, Dr. Théel informs me that in some of the Challenger Holothurids the integument has been entirely, and in others partially, decalcified, in consequence probably of some impurity in the spirit in which they were preserved. Possibly a similar process has occurred in the case of this Ascidian.

The Endostyle was not examined in *Culeolus perlatus*. In all the other species, ignoring the absence of spicules in *Culeolus perlucidus*, this organ is very similar. In *Culeolus murrayi*, *Culeolus wyville-thomsoni*, and *Culeolus recumbens* the greatest development of spicules is in the outer clear edge, and in the last species they are confined to that locality. In *Culeolus moseleyi*, however, though present in the clear edge also, they are more plentiful over the central opaque area.

There is nothing worthy of remark in the languets along the dorsal edge of the branchial sac.

The Tentacles.—The tentacles are very similar in all the species, and are of the ordinary Cynthiad type. In some of the larger ones, however, especially in *Culeolus murrayi*, one notices that peculiar puffing out of the lower or branchial membranous surface of the tentacle so characteristic of the organ in the Molgulidæ.[1]

In three of the species, *Culeolus murrayi*, *Culeolus wyville-thomsoni*, and *Culeolus perlatus*, the number of tentacles is sixteen, and they are of two sizes, eight of each being arranged alternately. In *Culeolus murrayi*, in addition to these, there are also a certain number of much smaller ones of various sizes, and having no apparent symmetrical arrangement. In *Culeolus wyville-thomsoni* one of the large tentacles situated in the dorsal region is very much larger than any of the others. In *Culeolus recumbens* the

[1] See H. de Lacaze-Duthiers, Les Ascidies Simples des côtes de France, Arch. de Zool. expér. et gén., t. vi. p. 477. Paris, 1877.

tentacles are also of two sizes, arranged alternately, but here there are twelve of each size.

In *Culeolus perlucidus* and *Culeolus moseleyi* the relative sizes and arrangements are not so definite. In the latter species the tentacles are small, and are the simplest and least branched forms found in the genus.

The Dorsal Tubercle.—This organ in *Culeolus murrayi* and *Culeolus wyville-thomsoni* has quite the ordinary structure, and resembles the simpler forms we usually find in the Cynthiidæ. In *Culeolus moseleyi* also the dorsal tubercle is not abnormal, having an ovate form, an aperture, and two twisted horns.

In two of the species, however, *Culeolus recumbens* and *Culeolus perlucidus* the organ is very different, and is apparently of a much simpler type. In both it takes the form of a somewhat elliptical mass with a simple straight aperture—merely the opening of the canal provided with thick lips, and not twisted or coiled in any way. In *Culeolus perlatus* I was unable to make out the dorsal tubercle without cutting the unique specimen more than I considered justifiable.

There is nothing notable about the nerve-ganglion. It occupies the usual position, is of elongated form, and gives off nerve trunks at the branchial and atrial ends.

I was unable to make any observations on the condition of the neural gland. From want of material I could not make a special object of this organ, and it was not noticed incidentally along with any other parts. In *Culeolus recumbens* and *Culeolus perlucidus*, however, where the region of the nerve-ganglion and the peritubercular area were carefully examined, it cannot have any great development; and it probably constitutes the mass forming the back of the dorsal tubercle, in which case the canal leading from the gland to the tubercle would be reduced to a minimum.

There is nothing worthy of special remark in the condition of the peripharyngeal bands, the præbranchial zone, and the peritubercular area.

The Alimentary Canal.—The structure and course of the alimentary canal was determined in those species of which there are more than a single specimen.

In all it is small relatively to the size of the body and compared with the branchial sac; and in all it is situated at the posterior end of the body and on the left side of the branchial sac. In all the œsophagus is short, the stomach large and well defined, and the intestine long and narrow, but here the general similarity ends.

In *Culeolus murrayi* the anterior or intestinal end of the stomach is rather the larger, while in *Culeolus recumbens* the œsophageal end is the larger. In both the wall is pushed out into a number of cæcal processes or diverticula. In *Culeolus perlucidus* the stomach is more elongated, tapers towards both ends, and has no cæcal processes. Though the exact course of the intestine differs in the three species, yet in all it runs for a short distance anteriorly along the ventral edge of the branchial sac, after leaving the stomach, and then turns dorsally, up the left side, and finally runs back posteriorly to end near the atrial aperture.

In *Culeolus recumbens* the dorsal part of the intestine or rectum is short compared with the ventral part next the stomach ; this is caused by the atrial aperture being situated on the dorsal edge, and not at the posterior end of the body. In *Culeolus murrayi*, where the atrial aperture is more posterior, the rectum is longer. In *Culeolus perlucidus*, where the atrial aperture is not quite posterior, the great length of the rectum is caused by its devious course.

The form and course of the alimentary canal in the genus are thus very similar to what is found in the majority of Simple Ascidians, and may easily be derived from the arrangement found in the genus *Ascidia* (fig. 15, left hand diagram) by twisting the rectum round posteriorly, so as to allow the anus to follow the atrial aperture from the anterior to the posterior end of the dorsal edge.

Ascidia. *Culeolus.*

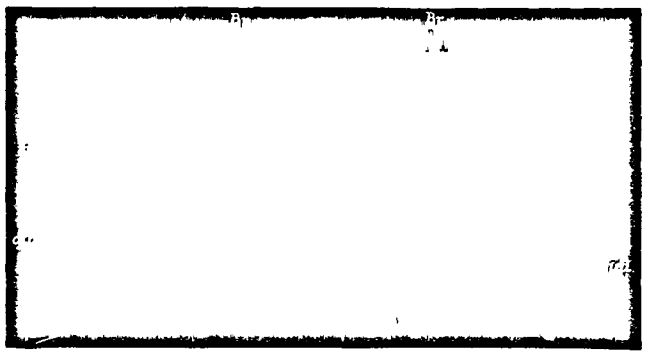


FIG. 15.—Diagrams of *Ascidia* and *Culeolus*, seen from the right side, to show the course of the Alimentary Canal. *Br.*, branchial aperture ; *At.*, atrial aperture ; *ped.*, peduncle ; *tn.*, tentacles ; *d.l.*, dorsal lamina ; *œ.a.*, œsophageal aperture ; *st.*, stomach ; *i.*, intestine ; *a.*, anus ; 1, intestinal loop ; 2, rectal loop.

Thus the rectal loop, or second intestinal curve (2), concave anteriorly in *Ascidia*, is entirely done away with in *Culeolus* (fig. 15, right hand diagram). In *Culeolus perlucidus* there is a rudiment of it, as the rectum is long, and, after running rather farther posteriorly and ventrally than the atrial aperture, has to curve up again dorsally, so as to bring the anus near it. If we compare this arrangement with that found in a species of *Ascidia* where the atrial aperture is placed far back on the dorsal edge, as in *Ascidia depressa*, the difference will appear very slight.

The course of the intestine in *Culeolus murrayi*, where the atrial aperture is posterior and the rectum runs straight towards it, is the simplest, and seems probably to have been the archaic form. *Culeolus perlucidus* has the atrial aperture rather more dorsal in position, and consequently there is a slight twist upwards in the terminal part of the rectum. *Ascidia* is a still more modified form in which the atrial aperture is normally at the anterior end of the dorsal edge, and here we find the rectal loop fully developed and the rectum running anteriorly in place of posteriorly as in *Culeolus*.

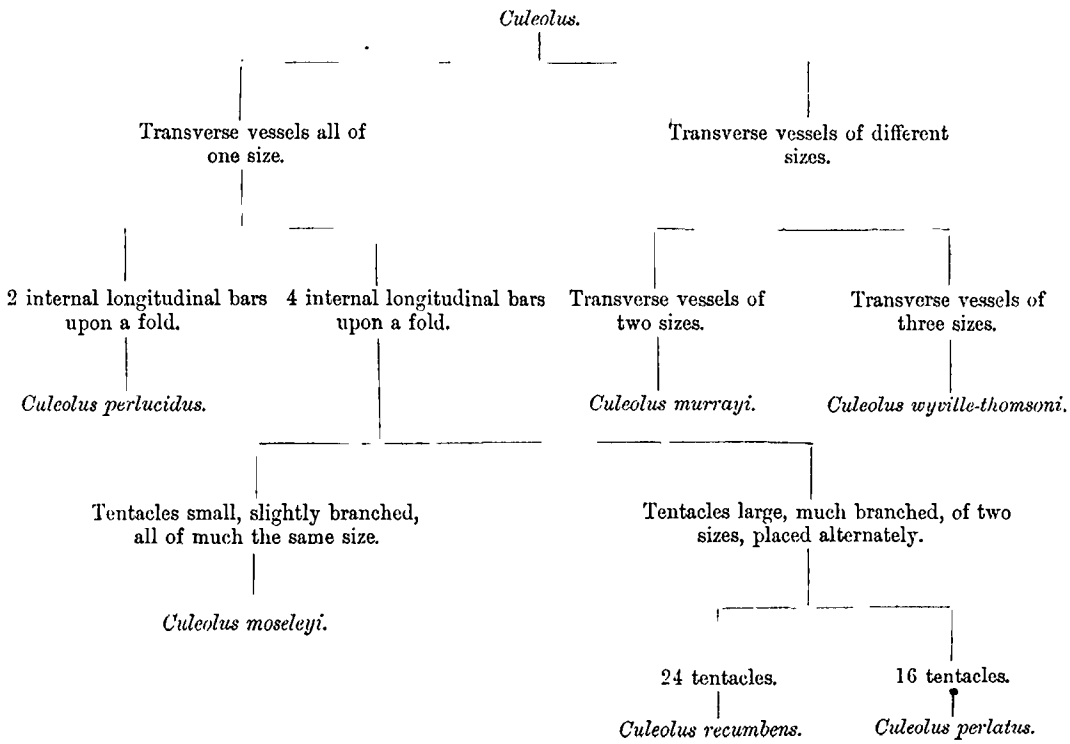
The Genitalia.—The genital glands, like the intestine, could only be examined in the three species of which there are more than single specimens.

In all they are in the form of hermaphrodite masses projecting from the inner surface of the wall of the peribranchial cavity, and developed on both sides. They are near the posterior end and rather nearer the ventral than the dorsal edge, those on the left side being in close relation to the rectum.

In *Culeolus murrayi* there are several quadrate genital masses on each side, more on the right side than on the left. Each mass consists of a spherical spermarium surrounded by masses of ova. The different spermaria are connected by a delicate vas deferens, so that all on the one side of the branchial sac have a common opening.

In *Culeolus perlucidus* there is a single genital mass on each side, lying parallel with the stomach, and having the excretory ducts directed posteriorly. In *Culeolus recumbens* there are three genital masses on each side of the body, and each opens by a distinct oviduct and vas deferens. In this species the rectum is distant from the stomach, and the genital glands on the left side lie in the wide intestinal loop, while in *Culeolus perlucidus* the rectum is in close contact with the stomach, the intestinal loop is narrow, and consequently the genital mass lies outside on the dorsal edge of the rectum.

The species of *Culeolus* may be distinguished by characters taken from the condition of the branchial sac and tentacles alone, as shown in the following table :—



Fungulus, n. gen.

Body globular, borne on a short thick peduncle attached to the anterior end. Branchial aperture triangular, atrial aperture bilabiate.

Test cartilaginous, but very thin, not modified on the peduncle.

Branchial Sac with several slight folds on each side; meshes square, no stigmata.

Dorsal Lamina a plain membrane.

Tentacles compound.

Genitalia a single gland on each side.

This genus is formed for a single Ascidian, which was at first considered as a *Culeolus*, but which seems to be sufficiently distinct to require a separate position. It is abnormal amongst Bolteninæ, as regards the condition of the peduncle, and on the strength of this character alone might be placed in the sub-family Cynthinæ, but it is probably more correct to place it here beside *Culeolus*, with which its internal structure shows it to have close affinities.

Fungulus cinereus, n. sp. (Pl. XIII. figs. 7–10).

External Appearance.—This species is club-shaped, and consists of a rounded knob-like body borne on a short thick peduncle. The body is globular, and not compressed laterally. The anterior end is rather wide, is directed downwards, and becomes continuous with the peduncle by its ventral edge. The posterior end is wide and rounded, especially at its ventral extremity. The dorsal edge is long and straight, but the ventral is strongly convex. The peduncle is continuous with the ventral edge of the anterior end; it is longer than the body, and about half as wide, and is attached by its lower extremity.

The apertures are distant, they are conspicuous, but scarcely projecting. The branchial is at the dorsal edge of the anterior end, not far from the point of attachment of the peduncle; it is slightly prominent, is rather large and open, and is surrounded by a circular raised lip within which are three flat lobes leaving the aperture triangular; it is directed anteriorly and slightly dorsally. The atrial is close to the posterior end of the dorsal edge; it is sessile, and not so conspicuous as the branchial. The aperture is in the form of a gaping transverse slit with anterior and posterior lips; it is directed dorsally and slightly posteriorly.

The surface is even, but minutely roughened on the peduncle. The body is nearly smooth, it is slightly wrinkled in parts, and a little incrusted with sand grains on the left side.

The colour is dark grey with a slate-blue tinge in parts.

Length of the body, ...	1·3 cm.
Breadth of the body, ...	1·2 „
Thickness of the body, ...	1·1 „
Length of the peduncle, ...	1·5 „
Breadth of the peduncle, ...	·5 „

The Test is thin, but moderately tough, and is between cartilaginous and membranous

in appearance. Minute rather distant projections on the outer surface give it a finely roughened appearance. The projections are slightly larger, and more numerous on the lips of the apertures.

The peduncle is hollow, but has the cavity crossed by delicate trabeculæ formed by prolongations of the thin test on each side. The matrix is homogeneous, but is traversed by irregularly running delicate fibres. Small rounded protoplasts are scattered through it; but there are no bladder cells nor pigment corpuscles, and no vessels are visible. The outer surface, especially of the papillary projections, is covered with adhering foreign particles, diatoms, &c.

The Mantle is very thin, and adheres closely to the inner surface of the test. The musculature is feeble, the bundles being narrow and distant; they are of a light brown colour, and form a wide-meshed delicate network.

The Branchial Sac is a wide-meshed coarse net with several folds on each side. The transverse vessels are wide and all of one size. The internal longitudinal bars are strong, and are only present on the folds, which are formed of three bars closely placed and united by short transverse ducts. In each interspace between the folds, but not placed symmetrically, there is a fine longitudinal vessel joining the transverse bars. The meshes formed by the folds and the transverse vessels are square or slightly elongated transversely. The internal longitudinal bars are ciliated on the sides, but not on the internal thickened edge.

The Endostyle is conspicuous. It is of a brown colour, and has prominent lips.

The Dorsal Lamina is a plain broad membrane.

The Tentacles are compound. They are large and considerably branched, but few in number.

The Alimentary Canal lies on the left side of the branchial sac, towards the ventral edge and posterior end. It is a long and narrow tube, with no distinct stomach.

The Genital Glands are two in number, one on each side of the mantle.

This is a most interesting form, on account of its evident relationship to *Culeolus*, as shown by the shape and position of the apertures, the place of attachment of the peduncle to the body, and especially in the structure of the branchial sac. The most striking difference from *Culeolus*, and in fact from all the other Bolteninæ, lies in the peduncle, which in the present species is evidently merely a short prolongation of the body (Pl. XIII. fig. 7), covered by test in the normal condition; while in all the species of *Culeolus* the structure of the test on the long thin peduncle is modified so as to give it the appearance of being a distinct organ attached to the body. Otherwise the external appearance is quite that of a *Culeolus*. The branchial aperture is anterior, just at the dorsal side of the peduncle, while the atrial is nearly posterior (Pl. XIII. fig. 7).

The test is thin, and its outer surface is slightly papillated, while the lips of the triangular branchial (Pl. XIII. fig. 8) and bilabiate atrial apertures are rough, with rather larger

and more numerous papillæ. In the small piece of test examined, no vessels were to be seen. The mantle, like that of the smaller species of *Culeolus*, is thin, and the musculature is feeble but distinct.

The most striking point of resemblance, however, is in the structure of the branchial sac (Pl. XIII. fig. 9). That organ has here the same simple type hitherto found only in *Culeolus*, and in *Bathyoncus*, one of the Styelinæ. The sac is especially like that of *Culeolus perlucidus*, from which it differs chiefly in that there the fold is formed of simply two internal longitudinal bars, while in the present species there are always three (Pl. XIII. fig. 9, *br.f.*) I have not been able to detect calcareous spicules in any part of the sac. Cilia are present on the internal longitudinal bars, but seem to be confined to the sides, being placed on the small cubical cells forming the lateral walls of the vessel, while the columnar cells on the free internal edge have none.

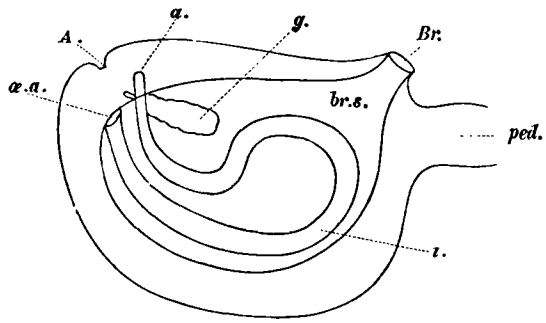


FIG. 16.—Diagrammatic lateral view of *Fungulus cinereus*, showing the course of the Alimentary Canal.
Br., branchial aperture; *At.*, atrial aperture; *ped.*, peduncle; *br.s.*, branchial sac; *æ.a.*, œsophageal aperture; *i.*, intestine; *a.*, anus; *g.*, genital gland of left side.

I could discover no languets. A plain band, about twice the breadth of an internal longitudinal bar, runs along the dorsal edge of the branchial sac, and appears to represent the dorsal lamina. The endostyle is very distinct, but has no calcareous spicules. The central area is about one-third of the entire breadth (Pl. XIII. fig. 10), and is traversed by three pairs of opaque brown bands (*c.b.a.*, and *l.b.b.*) running longitudinally. One of the prominent edges in the piece examined has the blood vessels engorged with brown blood corpuscles (Pl. XIII. fig. 10, *cap.*), while the other edge is clear and transparent. The tentacles are large and much branched. The exact number could not be made out, but it is probably about eight.

The alimentary canal is undifferentiated into regions, and hangs freely in the peribranchial space, having no attachment (except by blood vessels) to the mantle. The œsophageal aperture lies at the posterior end of the branchial sac (fig. 16, *æ.a.*), and the tube has the following course. It first runs ventrally and then anteriorly along the ventral side of the branchial sac. It next turns dorsally (*i.*) and posteriorly and then ventrally, so as to form a curve convex dorsally. It then turns posteriorly and finally dorsally so as to form a second curve, with the concavity dorsal this time, and thus reaches

the neighbourhood of the posteriorly placed atrial aperture close to which the anus (*a.*) opens.

There are two short sausage-shaped genital glands. The left one (fig. 16, *g.*), lies attached to the inner surface of the mantle, in the second intestinal loop (open dorsally). The gland on the right side is rather longer, and lies nearer the ventral edge and the posterior end than the middle. Its short duct is directed posteriorly and dorsally.

One specimen of *Fungulus cinereus* was obtained in the Southern Ocean, between the Cape of Good Hope and Kerguelen Island, at Station 147; December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; depth, 1600 fathoms; bottom temperature, 0°·8 C.; bottom, globigerina ooze.

Sub-Family CYNTHINÆ.

Body attached, sessile or very shortly pedunculated. Branchial and atrial apertures with four lobes each.

Test coriaceous, rarely cartilaginous, not covered with sand.

Branchial Sac with more than four folds upon each side.

Tentacles compound.

This sub-family includes the typical forms of the Cynthiidæ—the genera *Cynthia* and *Microcosmus*. It is clearly distinguished from the Styelinæ by the structure of the branchial sac and the tentacles, while it differs from the Bolteninæ in not having a peduncle. The short stalk present in one or two species of *Cynthia* (*e.g.*, *Cynthia cerebriformis*) is really merely the narrowed posterior end of the body.

Microcosmus, Heller.

Cynthia, Savigny, Mémoires sur les Anim. sans Vertèbres, pt. 2me, fasc. 1, p. 90. 1816. In part.

Cynthia, Delle Chiaje, Memoria sulla Storia e Notomia degli Animali senza Vertebre del Regno di Napoli, tom. iii. 1823–29. In part.

Microcosmus, Heller, Untersuch. ü. d. Tun. d. adriat. u. Mittelmeeres, Abth. 3, Wien. 1877, p. 3.

Cynthia, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices, Kjøbenhavn. 1880. In part.

Body attached, sessile, not incrusted with a continuous coating of sand. Apertures both four-lobed.

Test coriaceous, thin but tough.

Branchial Sac with more than four folds upon each side.

Dorsal Lamina a plain untoothed membrane.

Tentacles compound.

Intestine forming a narrow loop.

Heller (1877) distinguished *Microcosmus* from *Cynthia* on account of the plain-edged dorsal lamina and the narrow intestinal loop. In the third part of the Preliminary Report, published in 1880, I expressed a certain amount of doubt as to the sufficiency of the characters on which this genus was founded.

I am now of opinion, however, that as these characters, and especially the condition of the dorsal lamina, are apparently constant and are easily applied, and as the two groups of species (*Microcosmus* and *Cynthia*) seem fairly distinct, it is, if not absolutely necessary, at least convenient to retain both generic terms.

The Challenger expedition added two new species to the nine or ten already known, and found a large specimen of *Microcosmus polymorphus*, the common Mediterranean species, in a new locality.

Microcosmus helleri, Herdman (Pl. XIV. figs. 1–4).

Microcosmus helleri, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 54.

External Appearance.—The body is longish ellipsoidal in shape, with a projection at the anterior end; it is scarcely compressed laterally. It is attached by a small area at the posterior end of the ventral edge. The anterior end narrows rapidly into the truncated conical branchial projection; the posterior end is broad and rounded, and the dorsal and ventral edges are nearly straight and parallel. The branchial aperture is at the anterior end of the dorsal edge; it is terminal, on a large projection directed anteriorly and slightly ventrally. The atrial aperture is on the dorsal edge, about two-thirds or three-fifths of the way down, and placed on a hemispherical projection. It is not so prominent as the branchial aperture, and is directed dorsally and a little posteriorly.

The surface is wrinkled and roughened, but not covered with excrescences; the branchial and atrial projections are much corrugated and thickened; a few Zoophytes, Polyzoa, &c., are found adhering, especially on the left side and posterior end.

The colour is a dull gamboge yellow, with a little reddish-brown at the posterior end and on the left side.

Length of the body, 8 cm.; breadth of the body, 4 cm.

The Test is leathery; it is rather thin, except at the area of attachment and on the siphons. The inner surface is white with a few yellowish-brown patches.

The Mantle is strongly muscular on the right side and the dorsal part of the left; it is membranous on the ventral part. The musculature is strong and regular.

The muscular band at the base of the branchial siphon, and just above the circle of tentacles, bears four large bluntly conical processes projecting into the lumen of the tube.

The Branchial Sac has six folds on each side. The alternate transverse vessels are larger than the intermediate ones, and about every fifteenth larger transverse vessel is very much wider than the others. The internal longitudinal bars are numerous. There are eight only on the folds and about twelve in the interspaces, each of which has six wide and six narrow rows of meshes. The largest meshes contain each six to eight stigmata.

The Dorsal Lamina is a plain membrane.

The Tentacles are compound, they are twenty in number, and of two sizes placed large and small alternately.

The Dorsal Tubercle is broadly cordate, with both horns rolled inwards.

In external appearance this species is not unlike *Microcosmus polymorphus*, Heller, but it is scarcely so rough and irregular in shape. The apertures are both distinct and prominent (Pl. XIV. fig. 1), especially the branchial, and the test in their neighbourhood is considerably thickened and corrugated, elsewhere it is rather thin. The mantle is strong, and muscle bands are greatly developed on the right side and on the dorsal region of the left. In the branchial siphon, above (anterior to) the circlet of tentacles, four large bluntly conical processes project from the lower edge of the sphincter muscle into the lumen of the tube, and form a sort of imperfect diaphragm.

Another point in which this species differs from *Microcosmus polymorphus*, is the branchial sac, which has only six folds on each side. The folds are rather narrow compared with the interspaces (Pl. XIV. fig. 2). The transverse vessels are strong, and are usually alternately larger and smaller (the latter are very frequently traversed by the stigmata). Sometimes, however, there are three sizes occurring alternately (Pl. XIV. fig. 4, *tr.*, *tr.'* and *tr.''*). Besides this, about every fifteenth vessel is enormously enlarged (Pl. XIV. fig. 3, *tr.x.*), and forms a broad band traversing the sac.

There are eight or nine internal longitudinal bars on the upper side of the fold, so that the figure (Pl. XIV. fig. 4, *br.f.*), only shows half of the fold. The meshes in the interspace between the folds are of two distinct sizes, and there are six of each kind. The larger ones are overlapped by the fold, and about three of them are usually hidden (Pl. XIV. fig. 2).

One specimen of this species was obtained in Torres Strait, between Australia and New Guinea, at Station 188; September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E.; depth, 28 fathoms; bottom muddy.

Microcosmus propinquus, Herdman (Pl. XIV. figs. 5 and 6).

Microcosmus propinquus, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 55.

External Appearance.—The body is oblong-ovate or almost triangular in shape, and is compressed laterally. It is attached by the posterior two-fifths of the ventral edge. The anterior end is narrow, and terminates in the branchial projection; the dorsal and ventral edges slope backwards to the broad and rounded posterior end. The branchial aperture is terminal, and is situated on a large projection turned ventrally and slightly to the left side. The atrial aperture is also prominent; it is on the dorsal edge, three-fourths of the way from the anterior to the posterior end, and is directed dorsally.

The surface is wrinkled and minutely grooved, but not covered with excrescences; it is somewhat corrugated around the apertures, and has a few foreign bodies adhering.

The colour is pale yellow, with a reddish-brown tinge here and there.

Length of the body, 7·5 cm.; breadth of the body, 5 cm.

The Test is leathery, it is tough but rather thin. The inner surface is white and glistening.

The Mantle is strongly muscular on the right side, but membranous over the viscera. A narrow membrane projects into the branchial siphon above the tentacular circlet; it is slightly crenated, but does not bear large conical processes as in *Microcosmus helleri.*

The Branchial Sac has seven folds on each side. The transverse vessels are all of one size. The internal longitudinal bars are strong and numerous; there are about six on the fold and the same number in the interspaces. The meshes are transversely elongated, and contain each about twelve stigmata; generally a fine transverse vessel divides the mesh into two.

The Dorsal Lamina is not broad, but rather thick; the edge is plain.

The Endostyle is very broad.

The Tentacles are about twenty in number. There are six large, six small, and some intermediate very minute ones which are not present in all the interspaces.

The Dorsal Tubercle is irregularly cordate, and has both ends turned inwards.

This species is nearly allied to *Microcosmus helleri,* and is not unlike it in external appearance (compare figs. 1 and 5 in Pl. XIV.). In the details of its anatomy, however, it differs considerably, the principal points being that the present species has fourteen folds in the branchial sac, while *Microcosmus helleri* has only twelve, and that the diaphragm in the branchial siphon is different.

The single specimen was attached by the posterior part of its ventral edge to the interior of a bivalve shell (Pl. XIV. fig. 5). The branchial aperture is conspicuous, and is directed ventrally. The test covering the siphon is not seamed and corrugated like that of *Microcosmus helleri;* over the rest of the body it is considerably wrinkled. The mantle is well developed, and forms a slight diaphragm at the base of the branchial siphon, which, however, does not form large processes, as in the case of *Microcosmus helleri.* The branchial sac (Pl. XIV. fig. 6) has wide meshes between the folds, containing each ten to fifteen stigmata. Most of the meshes are divided by a narrow horizontal membrane (*tr.'*), the wider transverse vessels (*tr.*) are all of one size.

One specimen was obtained off East Moncœur Island, Bass Strait, at Station 162, April 2, 1874; depth, 38 to 40 fathoms; bottom sandy.

Microcosmus polymorphus, Heller (Pl. XIV. figs. 7 and 8).

Microcosmus polymorphus, Heller, Untersuch. ü. d. Tun. d. adriat. Meer., Abth. 3, p. 6.

Microcosmus polymorphus, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 55.

(?) *Ascidia papillosa,* Carus, Beiträge zur Anatomie und Physiologie der Seescheiden, Meckel's Archiv., Bd. ii. p. 569, pls. vii. and viii., 1816.

The large specimen in the Challenger collection, which I have referred to this species differs somewhat externally from Heller's original description of *Microcosmus polymorphus*. It is smoother and less covered with excrescences. In internal structure, however, it agrees well, and I think there can be no doubt that it is the same species.

The branchial sac is yellow, and has seven large folds on each side. The difference in the proportion between the folds and the interspaces in this species and in *Microcosmus helleri* may be seen by comparing figs. 7 and 2 on Pl. XIV. There are about ten internal longitudinal bars on each side of the fold, and five or six in the interspace; they are very stout. The meshes contain from ten to fourteen stigmata each (Pl. XIV. fig. 8).

The tentacles are about twenty in number, compound, and of two sizes, placed large and small alternately. The dorsal lamina is smooth-edged.

This seems to be the species described in 1816, by Dr. C. G. Carus, in his "Beiträge zur Anatomie und Physiologie der Seescheiden," under the name of *Ascidia papillosa*. His fig. 2 on Pl. VII. is especially like the present species, and on the other hand his fig. 1 on Pl. VIII. shows a large rounded projection at the base of the branchial siphon: the other figures correspond very fairly with *Microcosmus polymorphus*.

One large specimen of this species, 11 cm. in length and 7 cm. in breadth, was obtained along with *Microcosmus propinquus*, off East Moncœur Island, Bass Strait, at Station 162, April 2, 1874; depth, 38 to 40 fathoms; bottom sandy.

Cynthia, Savigny.

Ascidia, Linnæus, O. F. Müller, Lamarck, Cuvier, &c. In part.
Cynthia, Savigny, Mémoires sur les Animaux sans Vertèbres, pt. 2me, fasc. 1, 1816. In part.
Halocynthia, Verrill, Bull. U. S. Nat. Museum, No. 15, p. 147, 1879. In part.
Cynthia, Heller, Untersuch. ü. d. Tun. d. adriat. u. Mittelm., Abth. 3, p. 9, 1877.
Cynthia, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices, 1880. In part.

Body attached, sessile or very shortly stalked, rarely incrusted with sand. Branchial and atrial apertures both four-lobed.
Test coriaceous, rarely cartilaginous.
Mantle well developed, usually with a strong musculature.
Branchial Sac with six to twelve longitudinal folds upon each side.
Dorsal Lamina with the free margin toothed.
Tentacles always compound.
Intestine forming rather a wide loop.

The genus *Cynthia* was founded by Savigny in 1816, for sessile Simple Ascidians with a coriaceous test, but at that time, and for long afterwards, it included all the other genera of the Cynthiidæ, with the exception of *Boltenia*. Of the groups into which Savigny divided his *Cynthia*, the Cynthiæ Simplices most nearly correspond to the present

restricted genus. Macleay, in 1823, separated *Styela* from Savigny's genus *Cynthia*, but this division was not accepted by other writers, and the term *Cynthia* continued to be used in the old sense until Heller, in 1877,[1] defined the four genera—*Microcosmus*, *Styela*, *Polycarpa* and *Cynthia*, using the latter in the restricted sense in which it is employed here.

A genus *Cynthia* was founded by Thompson subsequently to Savigny's "Mémoires," for a small group of Schizopodous Crustaceans allied to *Mysis*. Even although *Cynthia* is not now employed strictly as defined by Savigny, still it includes the most typical forms of Savigny's genus, and as it is generally recognised and accepted, there is no doubt that it ought to remain. There is more chance of confusion arising from the substitution of *Halocynthia*, as proposed by Verrill, than from the employment of the same generic name in a totally distinct class of animals.

Traustedt[2] admits the distinctness of *Styela* from *Cynthia*, but does not, however, accept Heller's *Microcosmus*. Hence Traustedt employs *Cynthia* in rather a wider sense than that in which it is used here.

The characters of *Cynthia* are those of the sub-family, with the exception of the features which distinguish *Microcosmus*. The body may vary greatly in shape, but is always attached, is very rarely stalked at all, and has never a long peduncle. The branchial and atrial apertures are both either square or surrounded by four lobes. The test is usually leathery; it may be thin but is always tough. Occasionally it is soft and cartilaginous, but never so much so as in the genus *Ascidia*. There are no hairs developed upon the outer surface,[3] and there is almost never an incrusting coat of sand. The mantle is usually very thick, and has the muscle bands strongly developed, forming two or three distinct layers.

The branchial sac is thrown into a series of strongly-marked folds, usually six or seven on each side, but more may be present (there are eleven upon each side in *Cynthia complanata*, and twelve upon each side in *Cynthia grandis*).

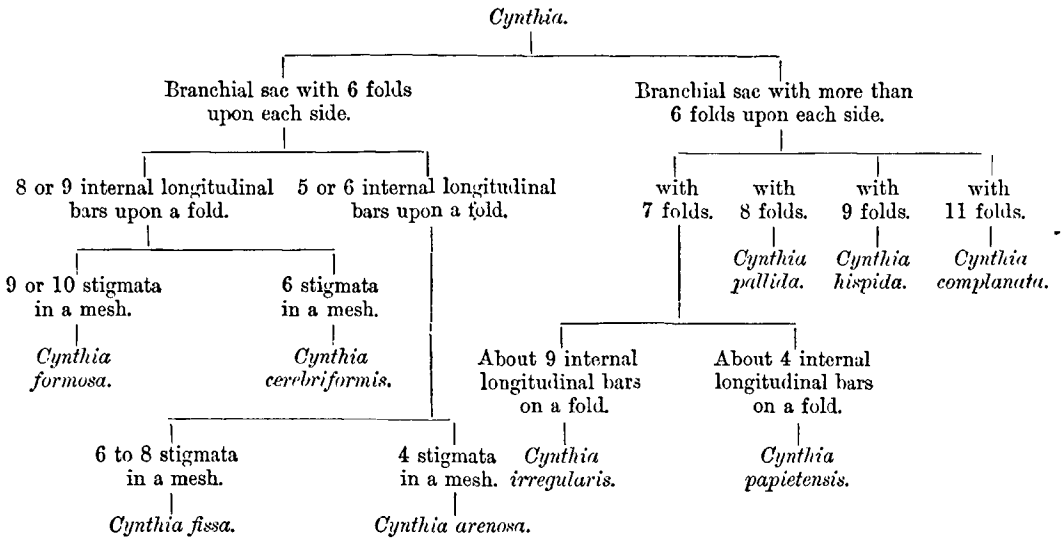
The condition of the dorsal lamina is one of the characters upon the strength of which Heller separated *Microcosmus* from *Cynthia*. In the latter genus the dorsal lamina has its free edge bordered by a series of short languets, while in *Microcosmus* it is a plain membrane. The tentacles are compound, and they do not differ appreciably from those of *Microcosmus*, or of the Bolteninæ.

The alimentary canal is usually large, and the stomach is distinct; the intestine forms a wide loop. The genitalia have various forms, but are developed upon both sides of the body, and are usually simple or lobed elongated masses.

The Challenger collection contains nine species of *Cynthia*, eight of which are new

[1] Untersuch. ü. d. Tun. d. adriat. und Mittelm., Abth. 3, Th. 1, Denkschr k. Akad. Wissensch. Wien, Bd. xxxiv.
[2] Oversigt over de fra Danmark, &c., Ascidiæ Simplices, vid. Medd. Nat. For., Kjøbenhavn, 1880.
[3] Except upon *Cynthia hispida* and the anterior end of *Cynthia formosa*.

to science. They may be distinguished by characters taken from the branchial sac alone, as shown by the following table :—



Cynthia cerebriformis, Herdman (Pl. XV. figs. 5–7).

Cynthia cerebriformis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 57.

External Appearance.—The body is irregularly pyriform; the anterior end is wide and is bent over greatly to the right side, which is concave, while the left is prominent and convex. The posterior end is drawn out into a short stalk, tapering towards the point of attachment. The apertures are not distant, both are terminal, and placed at the anterior edge of the right side, slightly projecting, and directed to the right and a little anteriorly.

The surface is sulcated all over, so as to closely resemble the convoluted surface of a brain; four large convolutions lead up to each aperture. The posterior end and the stalk are wrinkled, but not sulcated like the rest. The colour is dirty yellowish-white, becoming brown on the stalk.

Length of the body, 6·5 cm.; breadth of the body, 4·7 cm.

The Test is thick, and very stiff and solid; it is white on section and on the inner surface.

The Mantle is very thick, and is muscular at the anterior end. The branchial siphon is short and wide; the atrial is narrower, but nearly twice as long.

The Branchial Sac has six folds on each side. The internal longitudinal bars are numerous, there are about nine on a fold, and the same number in the interspace. The transverse vessels are all of the same size. The meshes are occasionally divided by narrow horizontal membranes, and contain each six stigmata.

The Dorsal Lamina is represented by a series of closely placed, stout, tapering, languets.

The Tentacles are branched; they are twenty in number, ten large and ten small, placed alternately.

The Dorsal Tubercle is rather large; it is elliptical in outline, and is placed with its transverse axis directed anteriorly and posteriorly, the opening being at the right side; both horns are turned in and form moderately large spirals.

This is a very striking species, and although an ordinary *Cynthia* in its structure, is quite unlike any other species in external appearance (Pl. XV. fig. 5). The anterior end is large and rounded and bears the two apertures, while the posterior is prolonged backwards into a short stalk by which the body is fixed. The entire surface is raised into convolutions which, taken along with the yellowish white colour, suggested the specific name *cerebriformis*. The apertures lie upon the right side, which is concave, while the left is strongly convex. It looks as if the anterior end, bearing both apertures, had been forcibly bent over, so as to form the front of the right side. The openings are very distinct (Pl. XV. fig. 5), and each is surrounded by four prominent lobes.

The branchial sac (Pl. XV. fig. 6) is that of a typical *Cynthia*. The folds are large, and have each a number of internal longitudinal bars, which are closely crowded at the crest of the fold. The transverse vessels are all of one size and are rather strong. The meshes are slightly elongated transversely, and are usually not divided; they contain from five to seven stigmata each.

The dorsal tubercle is large, and lies in rather a shallow peritubercular area (Pl. XV. fig. 7). The opening between the spirals is directed to the right side; each spiral is composed of about two turns, but the anterior is considerably the larger one.

The œsophageal aperture lies very far forwards in the branchial sac, and there is no distinct stomach. The digestive tube runs first posteriorly and then ventrally in irregular curves, so as to reach the ventral edge of the body, where it turns sharply round posteriorly, and then sweeps round the lower end of the body and turns anteriorly at the dorsal edge so as to reach the neighbourhood of the atrial aperture. The general course is similar to that found in the genus *Corella* amongst the Ascidiidæ.

One specimen of this curious species was obtained at Port Jackson, Australia, June 3, 1874; depth, 30 to 35 fathoms; bottom, rock.

Cynthia fissa, Herdman (Pl. XV. figs. 8–11).

Cynthia fissa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 58.

External Appearance.—The shape is ovate, with a deep cleft at the anterior end of the dorsal edge extending nearly half way through the body; it is slightly flattened laterally, and is attached by the posterior end and nearly the posterior half of the left side. The

apertures are prominent; they are placed at the extremities of the two projections formed by the cleft; the branchial projection is terminal, the atrial is on the dorsal edge, fully half way from the anterior to the posterior end, and is not so long as the branchial.

The surface is very irregular, and is much wrinkled and rough; on the right side the chief wrinkles run transversely. The colour is yellowish-brown.

Length of the body, 2 cm.; breadth of the body, 1·6 cm.

The Test is strong and stiff; it is white on the inner surface.

The Mantle is thick and moderately muscular.

The Branchial Sac has six folds on each side. There are six internal longitudinal bars on each side of a fold, and three in the interspace. The transverse vessels are wide, and are of two sizes placed alternately. The meshes, which are transversely elongated, contain each six to eight oval stigmata, and are sometimes divided by a narrow horizontal membrane.

The Dorsal Lamina has the free edge terminated by a series of tentacular languets.

The Tentacles are simply pinnate, and are about twelve in number.

The Dorsal Tubercle is large and irregularly oblong, and the aperture is anterior; both horns are turned to the left. It lies in a small, but deeply cup-shaped perituberculär area.

This curious little species looks, on account of the prominent anteriorly placed branchial and atrial apertures, as if the anterior end of the body had been deeply cleft (Pl. XV. fig. 8). In this respect, and in the markings on the surface, the species is rather like *Cynthia dura*, Heller,[1] from which it differs in the number of tentacles, the shape of the dorsal tubercle and several other particulars.

Cynthia fissa is also like *Cynthia irregularis* in some respects. The external appearances are not very dissimilar, and the branchial sacs are very much alike in their minute details (compare Pl. XV. fig. 9, and Pl. XVI. fig. 11), but they differ in their coarser anatomy, as *Cynthia irregularis* has fourteen folds while *Cynthia fissa* has only twelve. The dorsal tubercles of the two species are entirely different.

The tentacles in *Cynthia fissa* are scarcely compound (Pl. XV. fig. 11). They look like the tentacles of a *Styela*, with a series of small buds projecting from each side. The dorsal tubercle is of the simple form very commonly found in *Ascidia*, and is deeply cup-shaped, with both horns turned to the left.

Several specimens were found adhering to the test of *Microcosmus polymorphus*, from Station 162, April 2, 1874; off East Moncœur Island, Bass Strait; 38 to 40 fathoms; bottom sandy.

[1] Untersuchungen ü. d. Tunic. des adriatischen Meeres, Abth. 3, p. 11, pl. iii. fig. 1.

Cynthia formosa, Herdman (Pl. XVI. figs. 1–5).

Cynthia formosa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 58.

External Appearance.—This species has a spherical body and a narrow stalk. The posterior end of the body is rounded, and the anterior is rather flatter; the dorsal edge is slightly more convex than the ventral. The stalk is about as long as the body, it is twisted and narrow, but expands slightly at the lower end where it is attached. The apertures are both at the anterior end; they are not distant, and are prominent.

The surface is smooth on the posterior half of the body, and is covered with fine silky spines on the anterior half; these increase in size towards the anterior end, and culminate in sheaves of long bristles, which surround and hide the apertures. The colour is grey.

Length of the body, 1·5 cm., breadth of the body, 1·3 cm.; length of the stalk, 1·6 cm.

The Test is thin but tough; it is semi-transparent on the posterior half of the body only.

The Mantle is thin but muscular; the muscle bands form a close net-work.

The Branchial Sac has six folds upon each side. The internal longitudinal bars are ribbon-like, and there are about eight on a fold and four in the interspaces. The transverse vessels are rather wide and are all of one size. The meshes are transversely elongated, and are divided usually by three narrow membranes; they contain each nine or ten stigmata.

The Dorsal Lamina consists of a series of small closely-placed languets, borne on the edge of a broad lamina.

The Tentacles are large and much branched, and are about twelve in number. Between these are a series of much smaller but also compound tentacles, placed usually two between each pair of large ones, and these again are separated by very minute simple projections.

The Dorsal Tubercle is simple; it is transversely elliptical, with the opening anterior, and the horns turned inwards.

This is a most elegant little species, and seemed at first sight, with its delicate peduncle and the coating of bristles upon the anterior end of the body, as if it might require to be separated generically from its congeners. It is, however, in internal structure quite a typical *Cynthia*, but it is the only one which has what may properly be called a peduncle (Pl. XVI. fig. 1). Here that organ really merits its name; it is thin and stalk-like, and fully as long as the body. The coating of hairs is very peculiar. It is only present upon the anterior end of the body, and around the terminally placed apertures it is exaggerated to form two clumps of bristles which terminate the body, anteriorly. The test upon the posterior half of the body is thin and semi-transparent and has no hairs.

There is little noteworthy about the branchial sac. The vessels are strong and the meshes are large, but each is divided transversely into three or four areas by delicate membranes (Pl. XVI. fig. 2). Figure 3 on Plate XVI. shows a small portion of the branchial sac, from the external surface, where the vessels are irregular. Several stigmata are apparently absent in two adjacent rows, leaving wide longitudinal ducts connecting the transverse vessels.

The dorsal lamina is a wide membrane, with a series of teeth or short languets placed along its free margin (Pl. XVI. fig. 4, *l.*). The tentacles are very numerous (Pl. XVI. fig. 5). There are twelve very large ones, with a row of branched pinnæ along each side (*tn.*). Between each pair of these larger tentacles there are two smaller branched ones, very like the pinnæ of the larger ones, and separated from each other and from the larger tentacles by four or five small conical projections which may be considered as simple tentacles, so that there are three orders altogether, two of them compound and one simple; and there are twelve of the largest or first order, twenty-four of the second, and about 180 of the third (Pl. XVI. fig. 5). The præbranchial zone is broad and transparent, allowing the longitudinal muscle bands to show through distinctly.

The peritubercular area is very small, and does not enclose the dorsal tubercle, which is simple and somewhat reniform. The aperture is anterior, and the horns are simply turned inwards and not coiled (Pl. XVI. fig. 5, *d.t.*).

One specimen of this species was obtained in Torres Strait, between Australia and New Guinea; depth, 3 to 11 fathoms.

Cynthia arenosa, Herdman (Pl. XVI. figs. 6–9).

Cynthia arenosa, Herdman, Prelim. Rep., Proc Roy. Soc. Edin., 1880–81, p. 59.

External Appearance.—The body is irregularly ovate or sub-triangular in shape; it is elongated transversely, and not compressed laterally. The posterior end is broad and rather flat, the anterior is narrow; the dorsal and ventral edges are convex; and the body is not attached. The apertures are both at the anterior end; they are inconspicuous, are placed close together, and are cross-slit.

The surface is entirely covered, with the exception of the siphons, by a close layer of sand grains. The colour is grey.

Length of the body, 1·5 cm.; breadth of the body, 1 cm.

The Test is thin, but very stiff on account of the imbedded sand.

The Mantle is thin but strong; the muscle bands are well developed.

The Branchial Sac has six folds on each side. There are about five internal longitudinal bars on each fold, and the same number in the interspace. The transverse vessels are usually of the same size, but here and there, at distant intervals, very much wider ones occur, which equal at least an entire row of stigmata in breadth. The meshes are

square, and contain about four stigmata each. They are always divided transversely by a delicate membrane.

The Dorsal Lamina is formed of a series of small tentacular languets.

The Tentacles are compound, they are few, and are placed long and short alternately.

The Dorsal Tubercle is simple; it is rudely cordate in outline, with the opening anterior, and both horns turned inwards.

This curious little species is very unlike a *Cynthia* in external appearance. It is irregularly ovate in shape, is apparently unattached, and has the entire body covered with a close coating of sand grains (Pl. XVI. fig. 6). The inconspicuous apertures are not lobed but are cross-slit, or have each the appearance of four short slits radiating from a central point.

The branchial sac has six folds upon each side, but they are not very large, and have only five internal longitudinal bars on the outer slope of each. The occasional very wide transverse vessels are curious (Pl. XVI. fig. 7, *tr.*). Each looks exactly as if a complete row of stigmata had been obliterated, especially as the delicate transverse membranes stretch along them exactly as they do over the ordinary meshes. This branchial sac is a little irregular in some other respects. Here and there we find one of the ordinary transverse vessels (Pl. XVI. fig. 7, *tr.'*) interrupted for a short distance, and two meshes thrown into one, thus producing a few very long stigmata.

The dorsal lamina is formed of languets alone (Pl. XVI. fig, 7, *l.*). There is no membrane uniting their bases. They are placed one opposite each transverse vessel, and one opposite each horizontal membrane.

The dorsal tubercle is simple, and is more like the tubercle of an *Ascidia* than of a *Cynthia*. The aperture is anterior, and the horns are turned inwards but are not coiled (Pl. XVI. fig. 8, *d.t.*). The peritubercular area is shallow.

The tentacles are compound, and are few in number. They are of two sizes, and are very similar to those of the next species, *Cynthia irregularis*.

Several specimens of this little species were obtained in Torres Strait, between Australia and New Guinea, at Station 186; September 8, 1874; lat. 10° 30′ S., long. 142° 18′ E.; depth, 1 to 8 fathoms; bottom, coral sand.

Cynthia irregularis, Herdman (Pl. XVI. figs. 10–12).

Cynthia irregularis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 60.

External Appearance.—The shape is very irregular. The body is attached to a fragment of a shell by the right side near the dorsal edge and half way up from the posterior end. The posterior end is small, and nearly flat; the anterior end is broad, and is deeply cleft between the large divergent siphons, on the extremities of which the

apertures are placed. The branchial aperture is at the ventral edge of the anterior end; it is prominent, and is turned ventrally and a little to the left. The atrial aperture is at the dorsal edge of the anterior end; it is not quite so prominent as the branchial, and is turned dorsally and a little to the left.

The surface is very uneven, and is deeply wrinkled and rather rough. The colour is yellow and dark brown.

Length of the body, 4·5 cm.; breadth of the body, 3 cm.

The Test is thin, except at the posterior end, where it is thickened; it is tough and opaque, and is white on section and on the inner surface.

The Mantle is rather strong and muscular.

The Branchial Sac has the folds very slight and distant; there are seven on each side. The transverse vessels are mostly wide but irregular. The internal longitudinal bars are numerous; there are about nine on a fold and eight in the interspace, which has four wide and four narrow rows of meshes. The meshes contain each about four short oval stigmata, and are often divided by narrow horizontal membranes.

The Dorsal Lamina is formed of a series of narrow tentacular languets.

The Tentacles are compound, they are very small, and consist of twelve larger ones, with either one or two very minute ones between each pair of larger.

The Dorsal Tubercle is very large, but irregular; it is broken up into a number of curved pieces.

This species is very irregular in external appearance (Pl. XVI. fig. 10), and has a good deal the look of a *Microcosmus*, with its creased and furrowed, thin but tough and stiff test, of a yellow and brownish colour.

The branchial sac (Pl. XVI. fig. 11), is also rather irregular. There are fourteen folds, but they are not very wide although each has a considerable number of internal longitudinal bars upon its surface. The space between each pair of folds has usually eight rows of meshes, four of which are wide and four narrow (Pl. XVI. fig. 11).

The dorsal tubercle is the most remarkable feature in this species (Pl. XVI. fig. 12). It occupies the greater part of a triangular and rather deep peritubercular area, and is present in the form of eight or nine distinct apertures of irregular shapes, and each bounded by a raised lip. These apertures are arranged in the form of a deeply cup-shaped curve, and look as if they were the remains of a tubercle of the ordinary type, with the aperture anterior and both ends bent slightly to the left, which had had its originally single curved slit broken up into the series of separate apertures.

One specimen of this species was found at Port Jackson, Australia; depth, 2 to 10 fathoms.

Cynthia pallida, Heller (Pl. XVII. figs. 17–21).

Cynthia pallida, Heller, Beiträge zur nähern Kenntniss der Tunicaten, p. 14, Taf. iii. figs. 17, 18 (Sitzb. d. k. Akad. d. Wiss., Bd. lxxvii. Abth. 1, 1878).
Cynthia pallida, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 60.

The external appearance of this species has been fully described by Heller, and the Challenger specimens agree well with that description. The branchial sac has eight folds upon each side. One specimen has nine. There are six internal longitudinal bars upon the side of a fold, and only three in the interspace. The transverse vessels are of two sizes placed alternately (Pl. XVII. fig. 17, *tr.* and *tr.'*). The meshes are square or slightly elongated transversely; they contain each six or seven stigmata, and are divided by a narrow horizontal membrane (*h.'m.'*). As noticed by Heller, there are curious elongated and fusiform calcareous spicules in the branchial sac (Pl. XVII. fig. 17, *sp.*) and mantle of this species, and smaller ones are present in the test. When Heller described this peculiarity in 1878, it was, I believe, the first time such a thing had been noticed. Two of the new species of *Cynthia* discovered by the Challenger expedition (*Cynthia complanata* and *Cynthia papietensis*) show similar spicules in the test, mantle, and branchial sac.

In the present species, the spicules of the branchial sac are chiefly in the wider transverse vessels, and the internal longitudinal bars. They are elongated, slender, and pointed at both ends. In the mantle (Pl. XVII. fig. 18, *sp.*) they are more crowded, and are shorter and stouter. When enlarged sufficiently, it is seen that they are minutely echinated all over (Pl. XVII. figs. 19 and 20), and that the pointed spines lie all in one direction, and are arranged in closely placed transverse rows.

The dorsal lamina is in the form of a series of long tapering languets, united at their bases by a narrow membrane which, like the vessels of the branchial sac, contains elongated fusiform spicules (Pl. XVII. fig. 21). The tentacles are of two sizes, eighteen larger and eighteen smaller being placed alternately.

The dorsal tubercle is small, and is usually transversely ovate in shape. In one specimen examined both horns were coiled inwards, while in another one horn turned in and the other out, forming spiral coils.

In the third part of the Preliminary Report, some small specimens from Tahiti were included under this species. I have since determined that they are distinct, and they will be described below under the name of *Cynthia papietensis*.

Of the specimens of *Cynthia pallida* in the collection, one is from Simon's Bay, Cape of Good Hope; depth, 10 to 20 fathoms; and two are from Kandavu, Fiji Islands.

Cynthia papietensis, n. sp. (Pl. XVII. figs. 10–16).

External Appearance.—The body is irregularly ovate or elliptical in shape; it is transversely elongated, and compressed laterally. The posterior end is wide and rounded; the

anterior is also wide, and is flattened or slightly concave in the middle between the apertures. The dorsal and ventral edges are short and strongly convex, and the body is attached slightly by the left side and the posterior end. The apertures are both on the wide anterior extremity; they are moderately distant, slightly projecting, large, and four-lobed.

The surface is even but slightly roughened, and has a few shell fragments, &c., adhering here and there. The colour is a warm yellowish-brown.

Length of the body (antero-posterior), 1·5 cm.; breadth of the body (dorso-ventral), 2·3 cm.

The Test is cartilaginous, but thin and soft; it is semi-transparent, and is well supplied with blood-vessels with enlarged terminal knobs, and containing numerous short rod-like echinated spicules in their walls.

The Mantle is thin, and of a light brown colour. The musculature is feeble but distinct. It contains very delicate elongated fusiform spicules.

The Branchial Sac has seven folds on each side. There are four internal longitudinal bars on the fold, and two in the space between the folds. The transverse vessels are all of much the same size, and delicate fusiform calcareous spicules are present in abundance in their walls. The meshes are square or elongated transversely, and are divided by a delicate membrane. They each contain about six stigmata.

The Dorsal Lamina is represented by a series of rather small and closely placed tentacular languets.

The Tentacles are not large. There are fifteen larger and fifteen smaller compound ones placed alternately, and in addition there are about thirty minute simple processes, which alternate with the branched tentacles.

The Dorsal Tubercle is small and simple, ovate in form, and placed at the bottom of a triangular peritubercular area; the aperture is anterior and minute; the horns nearly meet, but are not coiled.

This little species is closely allied to *Cynthia pallida*, Heller, with which I classed it provisionally in the Third Preliminary Report (see Proc. Roy. Soc. Edin., 1880–81, p. 61); the two species differ, however, in several particulars. According to Heller,[1] *Cynthia pallida* is also found at Tahiti.

The two specimens from 20 fathoms differ slightly in external appearance (Pl. XVII. figs. 10 and 11) from the other five. They are not elongated transversely, and the atrial aperture is more dorsal in position (fig. 10). In colour also they differ, being milk-white in place of yellowish-brown. At first I was inclined to consider them as a distinct species, but as a detailed examination has revealed no structural differences, it is probable that they are merely individual variations, or at most a local variety.

[1] Beiträge zur nähern Kenntniss der Tunicaten, Sitzb. der k. Akad. der Wissensch., Bd. lxxvii., 1878, p. 15.

The dimensions given in the description are those of the large specimen figured (Pl. XVII. fig. 11) from 10 fathoms. The rest of the specimens are much smaller, and are about the size of the specimen figured from 20 fathoms (Pl. XVII. fig. 10).

The test contains numerous light brown blood-vessels, with terminal knobs (Pl. XVII. fig. 14), and also minute rod-like spicules, with slightly enlarged ends and transverse bands of minute echinations (fig. 15).

In a slide mounted by Mr. Murray during the expedition, and labelled "varia from Papiete Harbour," there is a squeezed specimen of a small Ascidian, which in all probability belongs to this species. Nothing can be made out in it except the test, which, however, shows the same structure as that of *Cynthia papietensis*, and contains exactly similar blood-vessels and spicules.

The mantle is thin, but contains distinct brown muscle bands, and has numerous very graceful fusiform spicules, tapering to fine points and minutely echinated in transverse bands.

The branchial sac is like that of *Cynthia pallida* in most respects, but has only fourteen folds. The transverse vessels are also apparently all of the same size, and the meshes are not elongated transversely (Pl. XVII. fig. 12). The delicate fusiform calcareous spicules (fig. 13) are found chiefly in the transverse vessels, and are very similar to those in *Cynthia pallida*.

The languets (Pl. XVII. fig. 12, *l.*) are small, and very closely placed. The tentacles (Pl. XVII. fig. 16) consist of three sets, two of which are compound, while the third set, alternating with the others, is simple. The peritubercular area is regularly triangular, and is rather deep, the small dorsal tubercle being entirely included in it (Pl. XVII. fig. 12, *d.t.*). The intestinal loop is wide.

There are seven specimens of this species in the collection, all from Papiete Harbour, Tahiti, Society Islands, September 28, 1875. Five of them are labelled "from 10 fathoms," and the other two, "from 20 fathoms."

Cynthia complanata, Herdman (Pl. XVII. figs. 1–9).

Cynthia complanata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 62.

External Appearance.—The body is elongated, oblong in shape, pointed at the anterior end, and flattened laterally; the dorsal edge is straight or slightly concave, the ventral is convex; the posterior end is wider than the anterior, but is narrow. The body is attached by the ventral edge of the posterior end. The branchial aperture is terminal, quadrangular, tubular and wide; the atrial is on the dorsal edge, one-third of the way down from the branchial aperture to the posterior end; it is slightly projecting, and is also quadrangular and wide.

The surface is irregular but smooth, and is slightly creased. The colour is a dirty white.

Length of the body, 5·6 cm.; breadth of the body, 2·7 cm.

The Test is soft and cartilaginous. It varies greatly in thickness, as it is thin on the anterior half, and then becomes thicker, while the posterior third is a solid mass of test substance.

The Mantle is thin; the musculature is rather feeble; the siphons are very wide. There are long, thin calcareous spicules found in the mantle.

The Branchial Sac has eleven folds on each side. There are eight internal longitudinal bars on a fold, and four in the interspace. The transverse vessels are mostly of the same size, but here and there a much larger one occurs. The meshes are slightly elongated transversely, and contain each about five stigmata; they are generally divided by delicate horizontal membranes.

The Dorsal Lamina is formed of short blunt membranous languets.

The Tentacles are branched; there are nine large and nine small placed alternately, and about eighteen very minute intermediate ones.

The Dorsal Tubercle.—The general outline is nearly circular, but considerably convoluted. Both horns are turned inwards, and slightly coiled.

This curious species has very much the appearance of an *Ascidia*, except that both the apertures are more or less square (Pl. XVII. fig. 1). The test is cartilaginous, and is very thick and solid at the posterior end. It contains quantities of short rod-like calcareous spicules (Pl. XVII. figs. 2 and 3). The spicules in the mantle (Pl. XVII. fig. 4) are like those found in *Cynthia pallida*, Heller, but are longer and thinner. They lie in the interior of long membranous tubes or sheaths (Pl. XVII. figs. 4, 5, and 6) which run in zig-zags in all directions through the mantle. The spicules seem to fit the sheaths exactly (fig. 6), and the echinations are placed in regular transverse rows.

The branchial sac has a large number of folds (22), and they are all well developed and have a number of internal longitudinal bars. The interspaces between the folds (Pl. XVII. fig. 7) are rather narrow, and have only four rows of meshes.

Occasionally very wide transverse vessels are found (Pl. XVII. fig. 7), but the others are all of one size. Small fusiform and curved spicules are found scattered chiefly through the transverse vessels. Two of them are represented more enlarged in Pl. XVII. fig. 8, to show the arrangement of the spines in regular transverse rows. The curiously convoluted dorsal tubercle is shown in Pl. XVII. fig. 9.

One specimen of this species was found at Port Jackson, Australia; depth, 6 fathoms.

Cynthia hispida, Herdman (Pl. XV. figs. 1–4).

Cynthia hispida, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 61.

External Appearance.—The body is ovate or irregularly circular in shape; it is flattened laterally, and is nearly as broad as long; the dorsal and ventral edges are strongly convex; the anterior end is broadish, and straight, and the body is attached by the

rather narrow posterior end. The apertures are both at the anterior end, are moderately far apart, and are placed on short dome-like projections, the ends of which are conspicuously four-cleft and covered with strong echinated hairs, which fringe the apertures. The branchial is directed anteriorly, and the atrial dorsally.

The surface is more or less wrinkled, and closely covered with a short down of prickly hairs, which occasionally, at the posterior end and most markedly around the apertures, increase in size, and form large branched bristles. The colour is dull brown, rather lighter around the apertures.

Length of the body, 6·6 cm.; breadth of the body, 5·6 cm.

The Test is not thick, but is leathery and tough; it is smooth and glistening on the inner surface.

The Mantle is thick, and the musculature is very strong and close, especially on the siphons.

The Branchial Sac has nine folds upon each side; the ventral folds, or those next the endostyle on each side, are very slight. The alternate transverse vessels are wider than the intermediate ones. The internal longitudinal bars are numerous, there are about twelve on a fold, and six to eight in the interspaces. The meshes are small and contain each about four stigmata.

The Dorsal Lamina is formed of a double series of very small languets.

The Tentacles are compound; there are about fourteen, and they are all nearly of the same length.

The Dorsal Tubercle is small, but very prominent; it is situated on a hemispherical projection, and is elongated transversely; both horns are coiled inwards.

There are two specimens of this species in the collection, both from Bass Strait. The larger specimen has the surface considerably more wrinkled and the apertures more prominent than is the case with the other. Both are attached by their posterior ends to the interior of bivalve shells. The apertures are very conspicuous, being placed upon dome-shaped projections, terminated by clumps of strong branched hairs (Pl. XV. fig. 1). The surface is strongly wrinkled, and more or less clothed with short hairs. The test is leathery and tough, and the mantle is thick and has its musculature well developed.

The branchial sac has eighteen folds, each of which has a large number of internal longitudinal bars (Pl. XV. fig. 2, *br.f.*)

The dorsal lamina is peculiar (Pl. XV. fig. 3, *l.* and *l.'*). In addition to the usual series of triangular languets (*l.*), there is a second series of similar but rather smaller and more numerous processes (*l.'*) running parallel with the first series, and separated from it by a shallow groove. The dorsal tubercle is small but prominent (Pl. XV. fig. 4). It is simple and symmetrical, both horns being coiled inwards.

Two specimens of this large species were obtained off East Moncœur Island, Bass Strait, at Station 162; April 2, 1874; depth, 38 to 40 fathoms; bottom, sand.

Sub-family STYELINÆ.

Body attached, sessile, rarely incrusted with sand. Branchial and atrial apertures either four-lobed or cross-slit.

Test usually coriaceous, rarely cartilaginous.

Branchial Sac with four or less than four folds upon each side.

Tentacles simple, unbranched.

This section of the Cynthiidæ represents the Cynthiæ Styelæ and Cynthiæ Pandociæ of Savigny's system, and corresponds to the genus *Styela* alone as used by Macleay, Fleming, and Traustedt, with the addition of *Pelonaia*, and the new Challenger genus *Bathyoncus*. It is a very distinct sub-family, and can be clearly distinguished from both the Bolteninæ and the Cynthinæ by two important characters:—(1), the branchial sac has never more than eight longitudinal folds, four upon each side; and (2), the tentacles are always simple.

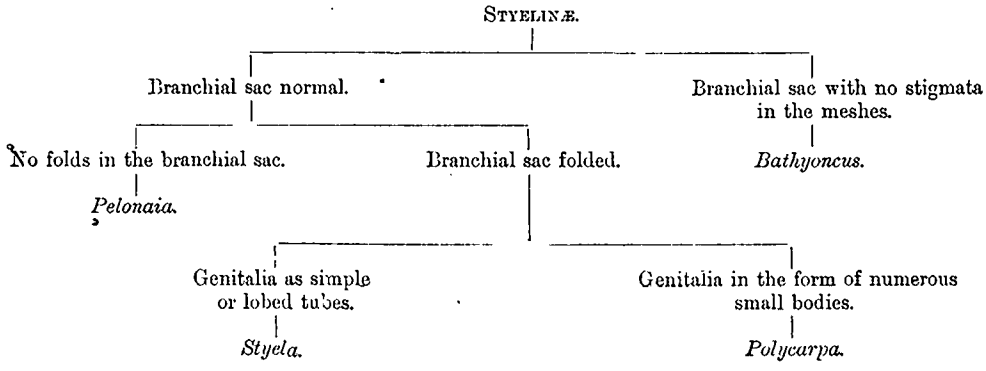
Savigny recognised these characters in both his third and fourth tribes of Cynthiæ,—the Styelæ and Pandociæ, and Macleay, who in 1823 formed Savigny's tribes into genera, distinguished those with only eight folds and unbranched tentacles from *Cynthia* and *Caesira*, which had a greater number of folds and possessed compound tentacles. But both these writers went on to sub-divide the group further according to the condition of the genital organs. Thus Savigny distinguished the Cynthiæ Pandociæ from the Cynthiæ Styelæ on account of the presence in the former of a single ovary placed in the intestinal loop. R. Hertwig[1] has, however, shown that Savigny was mistaken as to the nature of the body which he called the ovary, and probably the Pandociæ agree with the Styelæ in having genital glands upon both sides of the body.

Macleay formed three genera,—*Styela*, with at least one ovary on each side of the body; *Pandocia*, with a single ovary in the intestinal loop; and *Dendrodoa*, with a single ovary upon the opposite side of the body. *Pandocia* was probably founded from Savigny's mistaken account of the Cynthiæ Pandociæ, and *Dendrodoa* should, I consider, be merged in *Styela*. Various modifications of the genital glands occur among the species of this genus, and I think they can scarcely be relied upon as furnishing generic characters.

The genus *Pelonaia*, discovered and described by Forbes and Goodsir in 1840, and investigated since by M'Intosh, Kupffer and Traustedt, seems to me to fall naturally into this group. I have lately had an opportunity of dissecting *Pelonaia corrugata*, and it appears to be closely allied to *Styela*, and certainly does not require a distinct family or sub-family for itself.

[1] Jenaische Zeitschrift, Bd. viii. p. 96.

Heller in 1877,[1] distinguished *Polycarpa* from *Styela*, on account of the condition of the intestinal loop, and of the genital glands. This separation has not been accepted by Traustedt, but, although *Styela* and *Polycarpa* are undoubtedly very closely allied, I find it convenient, on account of the large number of species in both genera, to recognise the distinction until some species turns up which unites the characters of the two groups, and cannot therefore be placed in either. Consequently, with the addition of the new genus *Bathyoncus*, discovered by the Challenger expedition, I recognise four genera in the Styelinæ, and distinguish them briefly as follows :—



Styela, Macleay.

Ascidia, Linnæus, Sys. Nat., Edn. 12. 1766. In part.
Ascidia, O. F. Müller, Zool. Dan. Prod. 1776. In part.
Cynthia, Savigny, Mém. sur les Anim. sans Vert. Pt. ii. fasc. 1. 1816. In part.
Styela, Macleay, Anat. Observ. on the Tunicata. 1823.
Pandocia, Fleming, British Animals. 1828.
Cynthia, van Beneden, Recherches sur les Ascidies. 1846. In part.
Cynthia, Forbes and Hanley, Brit. Moll., vol. i. 1853. In part.
Styela, Hancock, Anat. and Phys. of Tunicata, Journ. Linn. Soc. 1868. In part.
Cynthia, Kupffer, Jahresber. der Commiss., &c. 1875. In part.
Styela, Heller, Untersuchungen ü. d. Tun. d. adriat. Meeres., Abth. 3. 1877.
Styela, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices. 1880. In part.

Body attached, sessile or almost so, rarely incrusted with sand. Branchial and atrial apertures either four-lobed or cross-slit.
Test usually thin but leathery, rarely thick and cartilaginous.
Branchial Sac with four or less than four folds upon each side.
Tentacles always simple.
Intestine forming a narrow loop.
Genitalia in the form of one or more simple, lobed, or branched tubular bodies.

[1] Untersuchungen ü. d. Tunicaten d. adriat. Meeres., Abth. 3, p. 19.

Although Savigny in his "Mémoires" introduced the name *Styela*, Macleay was, as far as I am aware, the first to use it as a generic term. This was in 1823, but the genus was not accepted by subsequent writers, and the species of *Styela* were included in *Cynthia* until 1868, when Hancock made use of the word "*Styela*" in a generic sense, and 1874, when Heller returned to the original spelling, and defined the genus *Styela* as it is employed here. Kupffer ("Jahresber. der Commiss., &c.," 1875) does not recognise any of the sub-divisions of *Cynthia*, and Traustedt accepts *Styela*, not in Heller's sense, but as including *Polycarpa*.

Styela is distinguished from *Pelonaia* and *Bathyoncus* very clearly by the structure of the branchial sac. It is more difficult to separate it from *Polycarpa*, but as I have said above (page 149), it is convenient to give generic names to the two groups of species, until we find a connecting link. Heller gave two characteristics by which they differ,—(1), the course of the intestine, which in *Styela* forms a narrow loop, while in *Polycarpa* it takes a wide, open curve; and (2), the genitalia, which are found in *Styela* as one, two or more, but never many, long simple or branched organs, while in *Polycarpa* they form a large number of generally small and rounded bodies scattered over the inside of the mantle upon both sides of the body, and called "polycarps" by Heller.

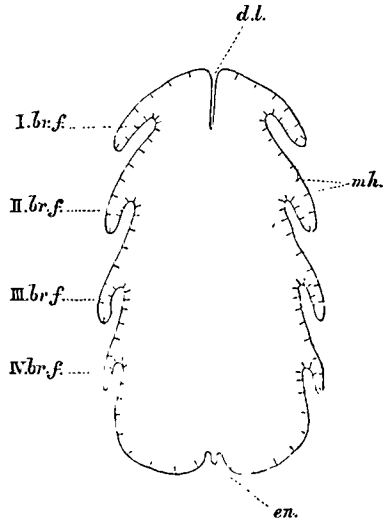


FIG. 17.—Diagrammatic transvers section of the Branchial Sac of *Styela*.
I., II., III., IV. *br.f.*, the branchial folds; *d.l.*, the dorsal lamina; *en.*, the endostyle; *mh.*, one of the meshes.

The branchial sac is found in various conditions in the genus *Styela*. In typical forms it has eight well-marked folds, four upon each side (fig. 17, I., II., III., IV. *br.f.*), and a greater number is never present; but many species have less than eight. The fold nearest to the endostyle on each side appears first to become slighter, less of a true fold, and more of a mere crowding together of the internal longitudinal bars, and then finally disappears. In *Styela grossularia* there is only one recognisable fold in the branchial

sac, placed in the dorsal region of the right side, but usually there are indications of the positions of more or fewer, usually of all seven, of the missing folds.[1]

In several of the new Challenger species (*e.g.*, *Styela flava* and *Styela oblonga*) the folds are absent as such, but are represented by eight longitudinal tracts, four upon each side, along which the internal longitudinal bars are very numerous, and are much more closely placed than in other regions of the sac. There can be no doubt that these are merely the folds in a rudimentary condition.

It has been necessary to modify somewhat Heller's definition of the genus, as in one of the newly discovered species (*Styela bythia*) the dorsal lamina is found in the form of languets. In most species of the genus, however, the dorsal lamina has, as Heller says, a smooth edge.

The Challenger expedition obtained only one known species (*Styela gyrosa*), the other eleven were new to science.

Styela bythia, Herdman (Pl. XVIII. figs. 1 and 6–8).

Styela bythia, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 63.

External Appearance.—The body is between cubical and hemispherical in shape, and it is scarcely flattened laterally. The anterior end is broad and obtuse. The dorsal and ventral edges slope backwards and slightly outwards, and the body is attached by a wide posterior end, slightly expanded at the margin. The apertures are sessile, inconspicuous and four-cleft; the branchial is at the ventral, and the atrial at the dorsal end of the anterior extremity.

The surface of the test is flat, but rough, especially at the anterior end.

The colour is dark brown, paler towards the posterior end.

Length of the body, 2 cm.; breadth of the body, 1 cm.

The Test is thick; it is very stiff, but rather brittle, and is white on section and on the inner surface.

The Mantle is reddish-brown. It is moderately thick, and is closely united to the test.

The Branchial Sac has four folds upon each side. There is a considerable space on each side between the endostyle and the most ventral fold. The transverse vessels are all of one size. The internal longitudinal bars are extremely numerous, and are much crumpled. The meshes are small and elongated antero-posteriorly; each contains one or two stigmata only, and is divided transversely by a delicate bar.

The Dorsal Lamina is in the form of a series of short languets.

This is a very interesting species, as it presents a combination of characters not previously known, and requiring an alteration in the definition of the genus.

[1] See Herdman, On Individual Variation in Simple Ascidians, Trans. Lit. Phil. Soc., Liverpool, for 1882.

Heller, in his diagnosis of *Styela*, states that the dorsal lamina has a smooth edge; but this species, which is undoubtedly a *Styela* in all its other characters, has a series of short tapering languets along the dorsal line of the sac. Another new species (*Styela flava*) has the dorsal lamina ribbed transversely, and slightly pectinated at the margin, evidently a condition intermediate between that seen in *Styela bythia* and that found in other members of the genus. Hence I had no hesitation in changing the characters of the genus slightly, so as to admit of the reception of *Styela bythia*.

It is a compact, irregularly hemispherical species, and was dredged from 2600 fathoms, attached to a manganese nodule, along with a specimen of *Styela squamosa* (Pl. XVIII. fig. 1. The lower specimen on the nodule is *Styela bythia*). The test is thick and stiff, but rather brittle. It adheres closely to the mantle below, but when detached shows a white inner surface.

The branchial sac (Pl. XVIII. fig. 6) looks rather thick and opaque. This appearance is caused by the large number of internal longitudinal bars present. These are broad and ribbon-like, and are so closely placed that the meshes between them usually contain only one or sometimes two stigmata each (Pl. XVIII. fig. 6). Otherwise the branchial sac has no very notable features. The transverse vessels are all of the same size, the meshes are small and particularly narrow, and are all divided transversely and symmetrically by narrow membranes. Figure 7 on Plate XVIII. shows a small portion of the sac from the outside and more highly magnified. The outline of the stigma is rather irregular, and no cilia could be discovered in any part of the sac which was examined.

The languets (Pl. XVIII. fig. 8, *l.*) are short but stout, and spring from a narrow, transversely ribbed membrane (*d.l.*) forming the basal part of the dorsal lamina.

One specimen of this interesting species was dredged to the south of Australia, at Station 160; March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; depth, 2600 fathoms; bottom temperature, 0°·2 C.; bottom, red clay.

Styela squamosa, Herdman (Pl. XVIII. figs. 1–5).

Styela squamosa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 66.

External Appearance.—The body is roughly hemispherical, and is slightly compressed laterally. The anterior end is very large, and rises somewhat towards its ventral extremity; the ventral edge is nearly straight, while the dorsal is gently convex. The body is attached by the wide posterior end, and the margin is slightly expanded. The apertures are sessile, distant and inconspicuous. The branchial is at the ventral end, and the atrial at the dorsal end of the anterior extremity.

The surface is smooth but scaly. The colour is creamy white and slightly yellow in parts.

Length of the body, 2 cm.; breadth of the body, 1·5 cm.

The Test is thick and solid, but soft.

The Mantle is very thin, and adheres slightly to the test.

The Branchial Sac has two distinct folds upon each side near the dorsal edge; and one or two more indistinct ones ventrally. The transverse vessels are all of one size. The internal longitudinal bars are numerous. The meshes are slightly elongated antero-posteriorly, contain each four or five stigmata, and are divided transversely here and there by a membrane.

The Dorsal Lamina is plain, and has no ribs nor teeth.

The Tentacles are larger and smaller alternately. The larger ones are short and stout.

The Dorsal Tubercle is a simple elliptical tubercle, with no visible markings.

This species (Pl. XVIII. fig. 1, the upper specimen) was obtained, along with *Styela bythia*, from 2600 fathoms. Although the two species are not unlike in external appearance, they differ greatly in their internal structure. *Styela bythia* has four well-marked folds upon each side of the branchial sac, while in *Styela squamosa* only two are distinct upon each side, the others being in a rudimentary state.

Then again the internal longitudinal bars in *Styela squamosa*, through broad and flat as in *Styela bythia*, are not nearly so numerous as in that species (compare figs. 2 and 6 on Pl. XVIII.), and consequently the meshes are not so narrow, and usually contain four or five stigmata in place of one or two. On the folds, however, they are of course more closely placed, and there the meshes are more nearly of the size found in *Styela bythia* (Pl. XVIII. fig. 4, *br.f.*). The meshes next the dorsal lamina contain each eight to ten stigmata (Pl. XVIII. fig. 5).

The dorsal lamina also differs from that of the last species, as it is a plain membrane with no ribs or other markings, and with no marginal teeth. (Pl. XVIII. fig. 5, *d. l.*). The tentacles (Pl. XVIII. fig. 3) are of two sizes, but both are small.

This species was obtained along with the last at Station 160; March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; depth, 2600 fathoms; bottom temperature, 0°·2 C.; bottom, red clay.

Styela grandis, Herdman (Pl. XIX. figs. 1 and 2).

Styela grandis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 67.

External Appearance.—The shape is irregularly pyriform, the anterior end being large and somewhat globular, while the posterior narrows into a short thick stalk, by which the animal is attached. The ventral edge is straight or slightly concave; the dorsal is long, and strongly convex. The branchial aperture is a little to the ventral edge of the anterior end, and is directed ventrally; the atrial is on the dorsal edge, about two-thirds of the way from the anterior to the posterior end, and is directed dorsally and slightly anteriorly. Both apertures are sessile; they are not very distinctly lobed, but are conspicuous.

The surface is irregular, but not rough; towards the base it is much corrugated transversely. The rest of the surface is more or less seamed and wrinkled. The colour is a dirty white, becoming slightly darker towards the base.

Length of the body, 9·5 cm.; breadth of the body, 6 cm.

The Test is thin and soft, but fairly strong.

The Mantle is very delicate, and is closely united to the inner surface of the test. The musculature consists chiefly of a number of fine bundles of fibres running longitudinally.

The Branchial Sac has four folds upon each side, and the most dorsal one on each side is placed very close to the dorsal lamina. There are three wide internal longitudinal bars on each side of a fold, and about six in the interspace. The alternate transverse vessels are wider than the intermediate ones. The meshes are immensely elongated transversely, and contain each about twenty stigmata.

The Dorsal Lamina is a rather wide and perfectly plain membrane, having no ribs nor teeth.

The Tentacles are simple; there are twenty long with occasional small intermediate ones.

The Dorsal Tubercle is heart-shaped, and both horns are turned inwards.

This is a large species, probably the largest species of *Styela* yet known, and it has more the appearance of an *Ascidia* than of one of the Cynthiidæ (Pl. XIX. fig. 1). The apertures are very peculiar; the branchial looks as if it had eight lobes and the atrial about six (the numbers characteristic of the genus *Ascidia*), but in reality there are only four principal lobes, and the others are merely small projections or folds lying between. The stalk is clearly the slightly narrowed posterior end of the animal, by which it is attached. This region is considerably seamed transversely.

The test is rather thin and soft, considering the size of the body, and is closely attached to the delicate mantle lying below it.

The branchial sac has the usual eight folds, but they are not large, and have comparatively few internal longitudinal bars. As a result the meshes are very wide (Pl. XIX. fig. 2), and contain in the spaces between the folds as many as twenty stigmata. Most of the transverse vessels are slight; they are much smaller than the internal longitudinal bars, and are alternately a little larger and a little smaller. Here and there, however, at considerable distances, a much wider transverse vessel occurs (Pl. XIX. fig. 2, near the top of the figure). All of these vessels have wide horizontal membranes attached to their inner surfaces (Pl. XIX. fig. 2, *h.m.*).

The tentacles are simple and are of two sizes. There are twenty of the larger size, and a smaller number of shorter ones which only occur in occasional spaces.

Two specimens of this large species were dredged in the Antarctic Ocean, to the south of

Kerguelen Island, at Station 150; February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bottom temperature, 1°·8 C.; bottom, rock.

Styela gyrosa, Heller.

(?) *Cynthia verrucosa*, Philippi, Müller's Archiv, 1843.
Styela gyrosa, Heller, Untersuch. ü. d. Tunicaten d. adriat. Meeres., Abth. 3, p. 15, 1877.

This large and apparently widely distributed species was found by the Challenger expedition at Port Jackson in considerable quantity. There are some large specimens of it from the same locality in the Liverpool Free Public Museum. They were dredged and brought home by Mr. Patterson.

As Heller (*loc. cit.*) has lately given a long description of the Mediterranean specimens, and as the Australian ones seem to correspond in all particulars, little remains to be said here. The Challenger specimens are even more massed together into pseudo-colonies than Heller's seem to have been, and occasionally half-a-dozen or more individuals are found united by the fusion of their tests into a rounded clump, placed upon an irregularly twisted peduncle, nine or ten centimetres in length.

A number of specimens were dredged in 6 fathoms of water at Port Jackson, Australia.

Styela convexa, Herdman (Pl. XIX. figs. 3–4).

Styela convexa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 69.

External Appearance.—The body is rudely hemispherical, or bluntly conical in shape, and is not flattened laterally. The anterior end and the sides are convex; the posterior end is large, and is attached to a stone, and slightly expanded at the edge. The branchial aperture is terminal, and is placed rather to the ventral side of the middle of the anterior end, but forms its most prominent point; the atrial aperture is moderately distant, at the dorsal edge of the anterior end; both are sessile and inconspicuous.

The surface is moderately smooth, and is finely creased in all directions, especially round the apertures. The colour is a dull yellowish-brown, but lighter on the margins of the posterior end.

Length of the body, 2 cm.; breadth of the body (dorso-ventral), 2·6 cm.

The Test is thin, but very tough; it is white on section.

The Mantle is closely united to the test, and has the musculature fine but close.

The Branchial Sac has four folds upon each side. There are about eight internal longitudinal bars upon a fold, and the same number in the interspaces. The meshes are elongated antero-posteriorly; each contains about three stigmata, and is divided transversely by a narrow horizontal membrane.

The Dorsal Lamina is slightly crimped but plain; the edge is even.

The Tentacles are simple, they are stout and rather curled, about thirty in number and all of much the same size.

The Dorsal Tubercle is simply oval; the aperture is at the narrower anterior end; the horns are not coiled, and nearly touch.

This is an ordinary and typical *Styela*, except that the apertures are not clearly four lobed, but seem to have one or two extra projections each (Pl. XIX. fig. 3). The mantle and test are closely united; both are thin but strong, the test being in the typical Cynthiad condition—namely, tough and leathery.

The branchial sac is normal. The eight folds are well marked, and the vessels and meshes are of an ordinary size (Pl. XIX. fig. 4). Two sizes of transverse vessels were noticed, but they do not seem to alternate regularly. Besides these, a delicate horizontal membrane appears to be invariably present, cutting each mesh into two areas (Pl. XIX. fig. 4, *tr.'*).

One specimen of this species was obtained in the Antarctic Ocean, to the south of Kerguelen Island, at Station 150; February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bottom temperature, 1°·8 C.; bottom, rock.

Styela lactea, Herdman (Pl. XIX. figs. 7–8).

Styela lactea, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 68.

External Appearance.—The body is nearly rectangular, varying from an oblong to a spherical shape; it is erect and not compressed. The anterior end is straight and wide, the posterior end is also straight and is nearly as wide. The dorsal and ventral edges are slightly convex. The body is attached by the whole of the posterior end. The apertures are both anterior; they are nearly sessile, and are four-cleft. The branchial is at the ventral edge of the anterior end, and is directed ventrally; the atrial is at the dorsal edge of the anterior end, and is directed anteriorly and dorsally.

The surface is smooth, but is seamed with transverse creases and slight folds, while longitudinal ones are seen here and there. The colour is a creamy white.

Length of the body, 4·5 cm.; breadth of the body, 3·5 cm.

The Test is thick, but soft and flexible; it is quite opaque.

The Mantle is closely attached to the test. The musculature is fine, and is composed of longitudinal and transverse bands intersecting at right angles.

The Branchial Sac has four folds upon each side. The internal longitudinal bars are rather few, but wide; there are about six on a fold, while they are few and distant in the interspaces. The meshes are greatly elongated transversely, some of those near the endostyle containing thirty or forty stigmata; they are occasionally divided by narrow horizontal membranes.

The Dorsal Lamina is a plain membrane, with no ribs, and an even margin.

The Tentacles are filiform; there are about thirty very long thin ones, with intermediate shorter ones.

The Dorsal Tubercle is large, and is transversely elliptical in shape; both horns are rolled inwards, and form large spiral coils.

This is an attractive-looking species, with its nearly rectangular form and milk-white soft looking test. From some points of view it looks like a little white barrel. The apertures are at the extremities of the anterior end, and are distinctly cross-slit (Pl. XIX. fig. 7).

The test is not at all like that of a typical *Styela*, it is thick, soft and flexible. The mantle is muscular but thin, and is closely attached to the test.

The internal longitudinal bars are wide ribbon-like bands, but they are few and distantly placed. Consequently the meshes are greatly elongated transversely, containing usually about fifteen stigmata each (Pl. XIX. fig. 8), but in some cases (*e.g.*, the most ventrally placed meshes) as many as forty. The transverse vessels are alternately larger and smaller (*tr.* and *tr.'*), while here and there the smaller ones fail, and a row of very long stigmata is formed. Delicate horizontal membranes are present, here and there, between the transverse vessels, dividing parts of the meshes, but they never extend far (Pl. XIX. fig. 8).

Three specimens of this species were obtained at Kerguelen Island, at depths of from 10 to 100 fathoms.

Styela exigua, Herdman (Pl. XIX. figs. 5 and 6).

Styela exigua, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 68.

External Appearance.—The body is quadrangular in shape; it is a little longer than broad, and is somewhat compressed laterally. The anterior end is broad and rather flat, while the posterior end is narrower and more rounded. The body is attached slightly by the posterior end of the left side. The apertures are sessile and inconspicuous; the branchial is terminal and median, the atrial is on the dorsal edge, one-fourth of the way down.

The surface is even, but partially covered by a thin coating of sand. The colour is a dirty grey.

Length of the body, 1 cm.; breadth of the body, 0·8 cm.

The Test is cartilaginous and thick, but soft.

The Mantle is very thin, and is closely united to the test.

The Branchial Sac is wide, with four folds on each side. The alternate transverse vessels are wider than the intermediate ones. The internal longitudinal bars are stout; there are six on each fold, and only one in the interspaces. The meshes are transversely elongated, and contain each about six stigmata.

The Dorsal Lamina is narrow, and has the margin plain.

The Tentacles are simple and numerous; they are of two sizes, placed long and short alternately.

This is the smallest species of *Styela* in the collection, and there is nothing notable in its external appearance (Pl. XIX. fig. 5). The test, which is comparatively thick, has a little sand adhering to its outer surface, especially upon the left side.

There are four folds upon each side of the branchial sac. They do not project much, but have each about six closely placed internal longitudinal bars (Pl. XIX. fig. 6, *brf.*), while there is only one bar in each interspace between two folds. The two rows of meshes lying between two folds are transversely elongated, and contain each about six stigmata; they are occasionally divided by delicate horizontal membranes (Pl. XIX. fig. 6).

One specimen of *Styela exigua* was obtained at Port Jackson, Australia, in from 2 to 10 fathoms of water.

Styela clava, Herdman (Pl. XIX. figs. 9, 10).

Styela clava, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 70.

External Appearance.—This species is club-shaped, the pyriform body being supported on a stalk of variable length; it stands erect, and is not compressed. The anterior end is narrow, but generally straight for a short distance; from this the body widens rapidly for the first two-fifths of its length, and then narrows more gradually in the remaining three-fifths, the posterior end being prolonged into the stalk, which is generally about equal to the body in length. The apertures are both at the anterior end; they are four-cleft, and more or less projecting, but minute and inconspicuous. The branchial is at the ventral edge of the anterior end, and is directed ventrally; the atrial is at the dorsal edge of the anterior end, is more prominent than the branchial, and therefore more anterior, and is directed anteriorly.

The surface is very irregular; the posterior half of the body and the stalk are creased longitudinally, and the anterior half of the body is nearly covered by irregularly shaped, but smooth and blunt knobs, mostly directed anteriorly. The colour is a dirty white, with occasionally a slight yellowish tinge.

Length (total), about 7 cm.; breadth (at broadest part of head), about 2 cm.

The Test is tough but thin, and almost papery, except in the knobs and processes.

The Mantle is very delicate, and is closely united to the test; the musculature is very feeble.

The Branchial Sac has four narrow folds upon each side. The internal longitudinal bars are rather numerous, about nine on a fold and twelve in the interspaces. The meshes are transversely elongated, contain each six stigmata, and are occasionally divided transversely by a narrow membrane.

The Dorsal Lamina is a smooth and plain membrane, with no ribs and no teeth.

The Tentacles are about thirty in number, and are rather closely placed; they are not large and are all of about the same length, but some are rather stouter than others.

The Dorsal Tubercle is transversely elongated, and the horns are simply curled inwards.

This appears to be rather a common species of *Styela* in Japanese seas. There are about twenty specimens of it in the British Museum collection, which were brought home from the Inland Sea, Japan, by Captain St. John, R.N., and there are also some specimens from the same locality in the Liverpool Free Public Museum. The species, however, appears never to have been described or figured.

The shape is very remarkable (Pl. XIX. fig. 9), as the posterior end is prolonged to form a distinct stalk, while the anterior part has the surface of the otherwise thin, pápery test raised up into knobs or tubercles, giving the animal a rugged appearance, and making it rather difficult to distinguish the apertures. These are both at the anterior end, but the atrial is a little in front of the branchial.

The branchial sac has the folds narrow, but the internal longitudinal bars are numerous. The transverse vessels are of two sizes, the larger is very wide and only occurs here and there (Pl. XIX. fig. 10, *tr.*), the other size is much smaller and more numerous. The meshes are nearly square, sometimes a little elongated antero-posteriorly, sometimes transversely, and contain four to seven (usually five or six) stigmata each (Pl. XIX. fig. 10).

There are about thirty rather closely placed tentacles, which vary a little in size, but are not arranged symmetrically. Several long, tubular, and slightly ramified genital glands are present upon each side of the body adhering to the inner surface of the mantle.

Several specimens of this species were dredged off Kobé, Japan, at Station 233A; May 17 to 19, 1875; lat. 34° 35′ N., long. 135° 10′ E.; depth, 8 fathoms and 50 fathoms; bottom, mud and sand.

Styela oblonga, Herdman (Pl. XX. figs. 7–9).

Styela oblonga, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 65.

External Appearance.—The body is oblong and erect; it is broadest in the middle, tapering slightly towards the anterior end, and more towards the posterior. The anterior end is straight, the dorsal and ventral edges are slightly convex, and the posterior end by which the body is attached is narrow. The apertures are four-lobed, sessile, and placed at the extremities of the anterior end.

The surface is finely wrinkled and roughened on rather more than the anterior half, whilst it is smooth and slightly incrusted with sand on the posterior part. The colour is a yellowish-brown, dull on the anterior half, and brighter posteriorly.

Length of the body, 3·5 cm.; breadth of the body, 2 cm.

The Test is not thick, but is tough on the upper part; it is thinner below, except at the posterior end, where it is considerably thickened.

The Mantle is thin and the musculature very delicate.

The Branchial Sac has four folds upon each side; these scarcely project, and are formed merely by a crowding together of the internal longitudinal bars, six to nine being placed close together, and separated by wide spaces containing only three bars each. The meshes are elongated antero-posteriorly, contain each only three stigmata, and are each divided transversely by a narrow membrane.

The Dorsal Lamina is narrow and much crumpled, but is neither ribbed nor toothed.

The Tentacles are simple and rather large, there are twelve of them.

The Dorsal Tubercle is rather prominent, it is cup-shaped, with a wide anterior opening.

This species was probably buried in sand nearly half its length. The posterior part of the test is of a different texture from the anterior, has a different appearance (Pl. XX. fig. 7), and is incrusted here and there with sand. The apertures are both sessile, four-lobed, and distinctly visible at the anterior extremity. The test is thin, leathery and tough, as in the typical Cynthiidæ. At the posterior end, it is considerably thickened.

The branchial sac has the folds in a rudimentary condition. They are no longer true folds and do not project into the cavity of the sac, but are merely longitudinal tracts along which there is a crowding together of the internal longitudinal bars (Pl. XX. fig. 8. *br.f.*). Consequently, the meshes on the inner surface of this branchial sac are of two sizes,—(1), the ordinary ones, which are nearly square and contain each usually three stigmata; and (2), the very much narrower ones, half a dozen rows of which represent the branchial fold. These last contain one or sometimes only part of a stigma. The transverse vessels are of two sizes placed alternately. The narrow horizontal membranes crossing the meshes are only present occasionally, and sometimes run for very short distances only (Pl. XX. fig. 8).

In this sac there are a considerable number of muscular fibres, which are present not only in the large transverse vessels, but also in the fine longitudinal interstigmatic vessels (Pl. XX. fig. 9, *m.f.*). The dorsal lamina is much crumpled, but has a smooth edge.

One specimen of this species was dredged in the South Atlantic (off the coast of Buenos Ayres), at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Styela flava, Herdman (Pl. XX. figs. 1–6).

Styela flava, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 64.

External Appearance.—The body is rudely spherical, but is slightly elongated later-

ally; the anterior end is convex; the dorsal and ventral edges are free and rounded. The body is attached by the posterior end and half of each side to a piece of coral. The apertures are sessile, four-lobed, and moderately far apart; they are placed at the opposite ends of the anterior extremity.

The surface of the test is flat, but is minutely scaly; these scales are largest and most distinctly marked around the apertures. The colour is light yellow, with a brownish tinge at the apertures, and is white on the area of attachment.

Length (antero-posterior), 1·6 cm.; breadth (from side to side), 2·4 cm.; thickness (dorso-ventral), 2 cm.

The Test is thin, but very tough; it is opaque, and is white and glistening on the inner surface.

The Mantle is rather thin; the muscular bands are numerous, but very fine.

The Branchial Sac has four folds upon each side. These are very slight, being merely the approximation of a number of internal longitudinal bars. There are about ten bars at these places, and ten in the intermediate opener parts. The meshes are square or elongated antero-posteriorly, contain each four stigmata, and are divided each into two areas by a narrow transverse membrane.

The Dorsal Lamina is ribbed transversely, and is slightly toothed at the edge.

The Tentacles are simple and of three sizes; there are fifteen large, fifteen small, and about thirty very minute ones, placed alternately.

The Dorsal Tubercle is placed at the bottom (posterior extremity) of a rather deep peritubercular area; it is small and irregular in shape.

This is in some respects rather an abnormal *Styela*. It is elongated laterally and depressed, thus forming a wide convex anterior extremity (Pl. XX. fig. 1), upon which the small cross-slit branchial and atrial apertures are placed.

The surface of the test is modified into a series of small polygonal areas, which give it a scaly appearance. Each of the rounded or polygonal areas is marked by a series of roughly concentric lines (Pl. XX. fig. 2), something like what Heller figures[1] in the case of *Cynthia dura*. The mantle is thin, but the muscle bands are very numerous. They are delicate and are placed irregularly, running in all directions and forming a close network (Pl. XX. fig. 3).

The branchial sac has the folds in a rudimentary state, and formed merely by the crowding together of the internal longitudinal bars along certain areas. In these regions the meshes are of course very narrow (Pl. XX. fig. 4, *br.f.*), while in the intermediate spaces they are rather wide, and contain each four large stigmata. The endostyle is conspicuous in this species; it is wider than usual, and is of a reddish brown colour.

[1] Untersuchungen ü. d. Tun. des adriat. Meeres., Abth. 3, pl. iii. fig. 3.

The dorsal lamina is in a condition rarely seen in the genus *Styela*. It is narrow, and the free margin is cut into a series of wide triangular notches, leaving outstanding teeth between them (Pl. XX. fig. 5). The membrane is also ribbed transversely; a long rib runs up the centre of each tooth to the apex, while between each pair of these there are a number (about six) of shorter ribs which do not reach the margin. This lamina presents a condition of affairs intermediate between the usual plain smooth-edged membrane of the typical *Styela*, and the large distinct languets of *Styela bythia*.

The tentacles are of three sizes, placed so that if we call the largest A, and the smallest C, they have the following arrangement:—A, C, B, C, A, &c. (Pl. XX. fig. 6, *tn.*, *tn.'* and *tn.''*). The peritubercular area is very large, and is much deeper than the dorsal tubercle, which is small and occupies merely the apex. Both horns are turned to the right, the one outwards and the other inwards (Pl. XX. fig. 6, *d.t.*).

The intestine is a narrow tube, and the loop which it forms is rather wide,—another point in which this species differs from the typical members of the genus.

One specimen of *Styela flava* was dredged in the South Atlantic, off the coast of Buenos Ayres, at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Styela glans, Herdman (Pl. XX. figs. 10–13).

Styela glans, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 65.

External Appearance.—The shape is regular, and is between conical and hemispherical. The highest point of the body is at the ventral edge of the anterior end. The posterior end is large and flat, and is attached to a piece of coral. The dorsal edge is more convex than the ventral. The branchial aperture is anterior, and is placed at the highest part, near the ventral edge; the atrial is on the dorsal edge, two-thirds of the way down; both are sessile and inconspicuous.

The surface is roughish, but regular. The colour is a dark reddish-brown.

Length of the body, 1·5 cm.; breadth of the body, 1·2 cm.

The Test is not thick, but is tough; it is white on the inner surface.

The Mantle is very thin and membranous.

The Branchial Sac has four slight folds upon each side, about five internal longitudinal bars being crowded together, and the same number placed further apart alternately. The meshes are elongated antero-posteriorly, and contain three stigmata each. They are divided transversely by narrow membranes.

The Dorsal Lamina is a narrow membrane.

The Tentacles are simple; they are few and of moderate size.

The Dorsal Tubercle is simple; it is nearly circular in outline.

This is a small regularly shaped species, rather like an acorn in appearance (Pl. XX).

fig. 10). The apertures are sessile and inconspicuous, and in their present contracted condition appear to be scarcely lobed. The test is coriaceous and tough, coloured dark reddish-brown upon the outside, and white internally.

The folds in the branchial sac are in the same rudimentary condition as in the two preceding species. On the folds there are about five closely placed internal longitudinal bars, and between these regions there are about the same number of bars placed further apart. The meshes in the spaces between the folds are elongated antero-posteriorly, and contain each three stigmata. The transverse vessels are of two very distinct sizes (Pl. XX. fig. 11, *tr.* and *tr.'*) placed alternately, while a still smaller size (*tr.''*), in the form of a delicate bar, stretches across each row of meshes. Very delicate muscle-fibres are visible in the transverse vessels, and also in the fine longitudinal interstigmatic vessels (Pl. XX. fig. 12, which shows also the mode of union of the delicate horizontal bar (*tr.''*) with the internal longitudinal bar, *i.l.*). Figure 13 on Plate XX. represents the posterior end of the ventral edge of the sac, to show the lower extremity of the endostyle (*en.*), and the ridge which is continued from it round the end of the branchial sac to join the posterior extremity of the dorsal lamina. This figure also shows how the internal longitudinal bars (*i.l.*) join the flat membrane at the lower end of the branchial sac.

One specimen of *Styela glans* was dredged in the South Atlantic, off the coast of Buenos Ayres, at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Styela radicosa, n. sp. (Pl. XXIV. figs. 6 and 7).

External Appearance.—The body is elongated, ovate or pyriform in shape; it is not compressed, and is attached by the posterior end. The anterior end is produced and pointed, the posterior is broad and rounded, and is prolonged at the edges into several long branched processes for attachment. The dorsal and ventral edges are nearly straight, and converge towards the narrow anterior end; the dorsal is more convex than the ventral. The branchial aperture is terminal; it is sessile but conspicuous, is indistinctly lobed, and is directed anteriorly and ventrally; the atrial is on the dorsal edge, one-third of the way down; it is sessile but conspicuous, and indistinctly lobed, and it is directed dorsally.

The surface is even and nearly smooth, in some places it is finely wrinkled transversely, and more rarely longitudinally; it is slightly corrugated around the branchial and atrial apertures. The colour is made up of various shades of creamy white, buff, and yellowish-brown, being lighter towards the posterior end and darker on the anterior end, and especially around the branchial aperture.

Length (antero-posterior, not including the root-like processes), 4·5 cm.; breadth (dorso-ventral), 2·8 cm.; thickness (lateral, at posterior end), 2·2 cm.

The Test is leathery; it is tough and firm, but thin, and is slightly thickened at the posterior end; it is white on section, and glistening on the inner surface.

The Mantle is rather thick, and is strongly muscular. It is firmly attached to the inner surface of the test in most places.

The Branchial Sac is large and moderately strong, and has four wide folds on each side converging towards the œsophageal aperture. The transverse vessels are nearly all of one size. Here and there, at distant intervals, a very much larger one is present. The internal longitudinal bars are broad and ribbon-like; there are six on each side of a fold, and the same number in the interspace. The meshes are transversely elongated, and contain each six or seven stigmata.

The Endostyle is prominent and conspicuous, and is rather undulating in its course.

The Dorsal Lamina is a plain broad membrane, with no ribs nor teeth. It extends for about two-thirds of the length of the branchial sac.

The Tentacles are simple; they are numerous, of several sizes, but not placed regularly.

The Dorsal Tubercle is placed in a moderately large peritubercular area; the shape is cordate, elongated transversely, and with the horns simply turned in; the aperture is anterior.

The most noteworthy feature in the external appearance of this species is the posteriorly placed root-like processes of the test, which are attached to fragments of shells and Polyzoa (Pl. XXIV. fig. 6); the longest process measures 1·5 cm. The widest part of the animal is just in front of the rounded posterior end, and the sides converge rapidly towards the narrow anterior end, which terminates in the branchial aperture. The surface is nearly smooth, the wrinkles being very fine and closely placed; they are present chiefly on the ventral edge of the right side. There are a number of radial corrugations round the apertures, but no distinct lobes.

The thin, tough yellowish test exactly resembles that of *Microcosmus*. The mantle is of a yellowish-brown colour, and has the musculature strongly developed. It is chiefly circular.

The folds in the branchial sac are large, and are supported by wide internal longitudinal bars (Pl. XXIV. fig. 7). The occasional wide transverse vessel (*tr.*) equals in size the height of a mesh. The stigmata have about the same breadth as the fine longitudinal vessels and are very regular. The meshes are also very uniform and are never divided transversely.

The endostyle is prominent and conspicuous, and is rather undulating in its course along the ventral edge.

The œsophageal aperture is placed about two-thirds of the way down the dorsal edge of the branchial sac.

One specimen of this species was obtained at Station 162, April 2, 1874, off East Moncœur Island, Bass Strait; depth, 38 to 40 fathoms; bottom, sandy.

Bathyoncus, n. gen.

Body ovate, sessile, slightly attached; apertures inconspicuous.
Test membranous and transparent.
Branchial Sac with several slight folds on each side, and a larger one on the left side near the dorsal edge; meshes square, no stigmata.
Dorsal Lamina a plain membrane.
Tentacles simple.
Alimentary Canal on the left side.
Genitalia a single elongated gland on each side.

This genus is formed for the reception of a single small specimen, found in deep water in the Southern Ocean. The chief peculiarity is in the structure of the branchial sac. Further remarks will be found under the description of the species.

Bathyoncus mirabilis, n. sp. (Pl. XXIV. figs. 8–12).

External Appearance.—The body is between ovate and discoidal in shape, and is compressed laterally. The anterior end is wide, slightly convex, and almost flat. The posterior end is narrower, and is slightly produced to form an area of attachment. The dorsal and ventral edges are equally but slightly convex, and converge towards the narrow posterior end. The sides are flattened. The apertures are both anterior, and are distant, inconspicuous and sessile; the branchial is near the anterior end of the ventral edge, and is directed ventrally and slightly anteriorly; the atrial is at the dorsal edge of the wide anterior end, and is directed anteriorly and dorsally.

The surface is even and smooth, except towards the posterior end, where it is a little irregular and rough from adhering sand, &c. The colour is pale yellowish-grey.

Length of the body, 1·4 cm.; breadth of the body, 1·2 cm.

The Test is thin, membranous, and rather transparent.

The Mantle is thin, and the musculature is not strong. The muscle bands are numerous and closely placed but very fine.

The Branchial Sac is very simple, forming a wide-meshed but strong network. There is one prominent fold on the left side, near the dorsal edge; and there are several others, much slighter, on each side. Each of these slighter folds is merely formed of three internal longitudinal bars, placed closely and united by short transverse ducts, which are twice as numerous as the transverse vessels, being placed both opposite to and between them. The transverse vessels are wide but distant, while the internal longi-

tudinal bars are very strong. The meshes intermediate to the slighter folds are large and square, and are not subdivided by any smaller vessels.

The Dorsal Lamina is a broad plain membrane, slightly undulating at the free edge.

The Tentacles are large and simple, from twenty to twenty-five in number, and all of one size.

The Dorsal Tubercle is small and simple, nearly circular in outline, and has the aperture anterior and rather wide. The horns are not coiled.

The Alimentary Canal is situated on the left side, near the dorsal edge.

The Genitalia are two elongated glands—one on each side.

This remarkable form is closely allied to *Styela*, from which it is separated generically on account of the peculiar branchial sac, which exhibits the simple structure only known in the two allied genera *Culeolus* and *Fungulus*.

In external appearance (Pl. XXIV. fig. 8) it is small and rudely ovate, with the posterior end narrow and roughened. On account of the thin and transparent test it looks rather like a *Molgula*. The mantle has a large number of muscle bands, forming a minute network, but they are very delicate. The branchial sac (Pl. XXIV. fig. 9) is, however, undoubtedly the most remarkable feature. It is formed of two series of vessels—the transverse and the internal longitudinal—intersecting at right angles. The internal longitudinal bars are placed in threes, and each set (forming one of the slighter folds or projections) is held together by a double series of short transverse vessels, smaller intermediate ones being placed between those which extend all round the sac. In other words, the smaller alternate transverse vessels are confined to the folds. The meshes between the folds (Pl. XXIV. fig. 9) are large and square. As no fine longitudinal vessels are present, there are no true stigmata. On the left side of the branchial sac, near the dorsal lamina, there is a collection of about six or eight internal longitudinal bars, forming a much larger fold.

The tentacles (Pl. XXIV. fig. 10) are simple and stout. They are not long, are all of one size, and are pretty closely placed. The anterior face of each is a flattened plain surface while the posterior or branchial is highly arched and somewhat irregular, the membrane being loose and puffed out in parts as in most Molgulidæ.

The dorsal tubercle (Pl. XXIV. fig. 11) is rather simple, and is placed at the anterior extremity of the funnel-shaped tube leading to the neural gland. The peritubercular area is not large, and has an irregularly triangular form. The nerve ganglion is large and oblong in shape. It gives off a considerable number of nerves at each extremity. Its anterior (branchial) end is just at the posterior angle of the peritubercular area.

The intestine is of much the same calibre throughout its length. It is rather small, and lies near the dorsal edge of the left side.

The genital glands are in the form of elongated undulating bodies attached to the inner surface of the mantle, one on each side, and converging towards the atrial aperture.

The genital duct is formed of two tubes lying side by side—the oviduct and the vas deferens. They open close together, not far from the atrial aperture, and close to the outer of two circlets of minute tentacular processes, which project from the inner surface of the cloacal wall close to the atrial aperture (Pl. XXIV. fig. 12). These processes seem like a pair of rudimentary diaphragms in the atrial siphon.

One specimen of this species was obtained in the Southern Ocean, between the Cape of Good Hope and Kerguelen Island, at Station 147; December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; depth, 1600 fathoms; bottom temperature, 0°·8 C.; bottom, globigerina ooze.

Polycarpa, Heller.

Cynthia, Savigny, Mémoires sur les Animaux sans Vertèbres. Pt. ii. fasc. 1. 1816. In part.
Ascidia, Quoy and Gaimard, Voyage de l'Astrolabe—Zool., t. iii. 1830–34. In part.
Cynthia, Forbes and Hanley, British Mollusca, vol. i. 1848–53. In part.
Styela, Hancock, Anat. and Physiol. of Tunicata, Journ. Linn. Soc. 1868. In part.
Cynthia, Kupffer, Jahresber. der Commiss., &c. 1875. In part.
Polycarpa, Heller, Untersuch. ü. d. Tunicaten d. adriat. Meeres., Abth. 3. 1877.
Polycarpa, Heller, Beiträge zur nähern Kenntniss der Tunicaten. 1878.
Styela, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices. 1880. In part.

Body attached, sessile, rarely stalked, occasionally incrusted with sand. Branchial and atrial apertures either four-lobed or cross-slit.
Test usually coriaceous, rarely cartilaginous.
Branchial Sac with four or less than four folds upon each side.
Tentacles always simple.
Intestine forming a wide loop.
Genitalia in the form of a large number of small masses scattered over the inner side of the mantle.

Heller separated *Polycarpa* from *Styela* in 1877, giving as the chief distinguishing features the wide loop formed by the intestine, and the presence of a large number of small genital glands, to which he gave the name of "polycarps." The close relationship of *Polycarpa* to *Styela* has been already discussed (see under *Styela*, p. 149).

In external appearance and the nature of the test this genus varies greatly. The typical condition is attached and sessile, with a thin but tough and leathery test, not incrusted with sand. A short stalk is however occasionally formed, as in *Polycarpa viridis*, by a prolongation of the posterior end of the body, and the test may become thickened and cartilaginous in consistency, as in *Polycarpa sulcata*. In some species incrusting sand is present in quantities ranging from a few adhering grains, as in *Polycarpa radicata*, to a complete coating, as in *Polycarpa tinctor*. While finally in *Polycarpa molguloides* the investment is very thick, and the grains are attached to long delicate hairs as in a typical species of the genus *Molgula*.

The mantle also varies considerably in its strength and degree of muscularity. In *Polycarpa sulcata* the mantle is strong, and (in the spirit specimens) has contracted completely away from the test, while in *Polycarpa quadrata* and others, it is thin and closely adherent to the inner surface of the test. The branchial sac agrees in all its characters very closely with that of *Styela*. The tentacles are invariably simple, but may differ greatly in size. The dorsal lamina may be slightly crenated at the edge, but is not known to be transversely ribbed or distinctly toothed.

The intestine usually curves round in rather an open loop, but this varies somewhat, and cannot be depended upon as a characteristic.

The reproductive system, however, is peculiar: there are a large number of distinct genital masses or polycarps present, scattered over the inner surface of the mantle, and projecting into the peribranchial space. Besides these there are usually a number of other distinct bodies, rounded, oval, oblong, or sometimes stalked, which at first sight appear very similar to the genital glands, but are in reality merely processes of the connective tissue of the mantle, which contain numerous blood sinuses, and have been called "endocarps." These may serve as pads to protect the genital masses lying between them, or may be reservoirs into which the blood circulating in the mantle passes when the body is violently contracted, as suggested by Kupffer.

There are twelve species of *Polycarpa* in the Challenger collection, and eleven of these were new to science, the only known species which was obtained being *Polycarpa tinctor*, Quoy and Gaimard.

Polycarpa viridis, Herdman (Pl. XXI. figs. 7–14).

Polycarpa viridis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 74.

External Appearance.—The body is variable in shape, but usually more or less pyriform, the anterior end being the broadest, and the posterior forming a short stalk, sometimes more elongated, and twisted, by the lower end of which the animal is attached. Both apertures are placed at the anterior end, generally a little to the right side of the extremity. The branchial is terminal or subterminal; the atrial is a little way down the dorsal edge, and not distant from the branchial; both are four-lobed, sessile, and inconspicuous.

The surface is not uneven, but is generally more or less covered by other animals, sand, shell fragments, &c., adhering to it. The colour is a dull green, and is darkest in the neighbourhood of the apertures.

Length of the body, 3 cm.; breadth of the body, 2·5 cm.

The Test is not thick but is tough; it is rough externally from adhering sand, &c., and is of a beautiful dark green colour throughout. Vessels are very numerous, and are seen anastomosing frequently.

The Mantle is muscular, is closely united to the test, and is of a dull green colour.

The Branchial Sac has four folds upon each side. There are three small transverse vessels between each pair of large ones. About eight internal longitudinal bars are usually present on the folds, and four in the interspace. The meshes are transversely elongated and contain each nine to twelve stigmata.

The Dorsal Lamina is narrow; it is not ribbed, and the margin is plain.

The Tentacles are simple, filiform, and crowded; there are about seventy, placed long and short alternately.

The Dorsal Tubercle is small and rudely circular in outline; the left horn is coiled inwards, and the right outwards.

This is a curious species; the shape is rather variable, as may be seen from the two specimens figured (Pl. XXI. figs. 7 and 8). The dimensions given above are those of a fairly large individual; some of the specimens are much smaller. The body is more or less globular, and the stalk is always very short. The apertures are slightly prominent and very distinctly four-cleft (Pl. XXI. fig. 8), the branchial is nearly terminal and towards the ventral edge, the atrial is on the antero-dorsal edge, about a quarter of the way round it from the branchial aperture to the posterior end. Sand, mud and fragments of shell adhere to the stalk and the posterior part of the body, and in some cases cover most of the surface. Where not thus concealed by foreign bodies, the surface has a rich dark green colour, the neighbourhood of the apertures being always the darkest part.

The dark green test is closely united to the underlying mantle, which is also green. Blood-vessels are very numerous on the test, and may be seen ramifying and anastomosing freely (Pl. XXI. fig. 9, *v.*). Minute ovate or fusiform cells of a yellowish colour are very numerous, scattered through the test matrix; while in its inner part, below most of the vessels, bundles of delicate fibres may be seen here and there, running in different directions (Pl. XXI. fig. 9, *f.*); these do not belong to the mantle. The large dark-coloured and mostly angular bodies, seen in fig. 9, are minute sand grains imbedded in the test matrix. The epithelium (ectoderm) on the inner surface of the test is distinct.

The branchial sac has four distinct folds upon each side, each fold having about eight closely placed internal longitudinal bars (Pl. XXI. fig. 10, *br.f.*). In the interspaces the bars are rather distantly placed, and consequently the meshes are large and contain each usually ten or eleven stigmata. The arrangement of the transverse vessels—three smaller ones alternating with two sizes of large ones—is very well marked and constant, and all of them have undulating or jagged edges, which appear to be due to irregular membranous expansions at their sides (Pl. XXI. fig. 10, *tr.*, *tr.'* and *tr.''*).

Muscular fibres are present in all the vessels, and are arranged with great regularity. The larger transverse vessels have two bands of fibres running along them, while the smaller vessels have a single band each. Longitudinal bands are also present. These lie in the inter-stigmatic vessels, and each band forks as it crosses one of the larger transverse vessels,

giving off a branch for each side of the nearest stigma. These branches unite soon with the corresponding divisions of the two adjacent bands to form the original number of longitudinally running bundles, one for each interstigmatic vessel (Pl. XXI. fig. 11).

The tentacles are numerous and are closely placed (Pl. XXI. fig. 12); they differ greatly in size. The dorsal tubercle is large and rather prominent (Pl. XXI. fig. 12, *d.t.*); both horns are coiled in the same direction, to the right.

The polycarps are numerous on the inner surface of the mantle, and vary from one to three millimeters in length. Each is hermaphrodite, and has the ovary occupying the centre and the rounded base (Pl. XXI. fig. 13), while the elongated spermatic vesicles are arranged around the periphery, so as to enclose and partially conceal the ova. These vesicles are fusiform or pyriform (Pl. XXI. fig. 14, *t.v.*), and their ducts join to form two canals, one on each side, which finally unite into the single vas deferens (*v.d.*), which runs alongside the short and wide oviduct (Pl. XXI. fig. 13, *o.d.*), and opens with it on the terminal papilla of the polycarp.

This species was found by the Challenger expedition at Port Jackson, Australia, where several specimens were obtained, at depths ranging from 2 to 15 fathoms, as follows:—17th April 1874, 2 to 10 fathoms, 1 specimen; 20th April 1874, 6 fathoms, 5 specimens; 23rd April 1874, 6 to 15 fathoms, 4 specimens.

Polycarpa tinctor, Quoy and Gaimard (sp.) (Pl. XXI. figs. 1–6).

Ascidia tinctor, Quoy and Gaimard, Voyage de l'Astrolabe—Zoologie, tom. iii. p. 608, pl. xci. figs. 1 and 2.

I have identified this species, found in considerable quantity by the Challenger expedition at Port Jackson, with the *Ascidia tinctor* of Quoy and Gaimard, entirely from the external appearance, as depicted in the atlas of the voyage of the Astrolabe.

The characteristic appearance of the Challenger specimens is shown well on Pl. XXI., where figure 1 shows a large specimen from the left side, the projection at the right side of the upper (anterior) end containing the atrial siphon. Figure 2 represents another specimen from the right side, while figure 3 is from the front, and shows the two conspicuous, distinctly four-lobed apertures. The atrial is always more prominent than the branchial, and is placed nearly one-third of the way down.

The test is thin and membranous, and is in all cases entirely covered with a close coating of fine sand.

The mantle is very muscular, and is only attached to the test here and there. The muscle fibres form continuous outer circular and inner longitudinal coats over the whole body. The sphincters around the siphons are very strong, and there is a partial diaphragm at the base of the atrial siphon, fringed with twenty short pointed lobes.

The branchial sac (Pl. XXI. fig. 4) has four well-marked folds upon each side (*br.f.*), and each of them has about eight internal longitudinal bars, while there are about the

same number more distantly placed in the interspaces. The transverse vessels are all much about the same size, and most of them have wide horizontal membranes hanging from their inner edges (Pl. XXI. figs. 4 and 5, *tr.* and *h.m.*). The meshes are square or a little elongated transversely, are often divided by delicate horizontal membranes (Pl. XXI. fig. 5, *h.m.*), and contain four or five stigmata each. The endostyle is well marked and may be seen distinctly running to the base of the long sac.

The tentacles are simple and are not long. They are of three sizes, placed usually with several of the smaller ones between each pair of larger ones (Pl. XXI. fig. 6, *tn.*).

The dorsal tubercle (Pl. XXI. fig. 6, *d.t.*) is large and prominent, and each horn forms a spiral; the right one is large and is turned inwards, while the left is much smaller and coils outwards. The peritubercular area is shallow and symmetrical. Both polycarps and endocarps are very numerous.

About a dozen specimens of *Polycarpa tinctor* were obtained at Port Jackson, at depths varying from 2 to 15 fathoms.

Polycarpa minuta, Herdman (Pl. XXII. figs. 1–4).

Polycarpa minuta, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 78.

External Appearance.—This species is dome-shaped, or nearly hemispherical; the anterior end is convex, and the posterior is wide, flattened, attached, and slightly expanded at the margin. The apertures are both anterior; they are not distant, and are sessile but distinct.

The surface is perfectly smooth and even. The colour is pale-yellowish brown.

Length of the body, 0·6 cm.; breadth of the body, 0·9 cm.

The Test is thin, but tough and strong.

The Mantle adheres closely to the test, and is very thin.

The Branchial Sac has four folds upon each side. The transverse vessels are all of the same size. The internal longitudinal bars are very few, there being only two between each pair of folds. The meshes are transversely elongated, and contain each six to eight stigmata.

The Dorsal Lamina is a plain membrane.

The Tentacles are numerous and filiform.

This is a very small species of *Polycarpa*, and is rather like *Styela grossularia*, van Beneden, in general appearance. It forms a small blister-like prominence on the stone to which it adheres (Pl. XXII. fig. 1), is perfectly smooth on the surface, and of a yellowish-brown colour. The apertures are placed close together at the anterior end. The test and the mantle are both very thin, and adhere together closely.

The branchial sac (Pl. XXII. fig. 2) has the folds in the rudimentary condition which

has been already seen in several species of *Styela* (*e.g.*, *Styela oblonga* and *Styela flava*). They are represented in this sac by four closely placed internal longitudinal bars (Pl. XXII. fig. 2, *brf.*), forming meshes which contain each one stigma only.

The transverse vessels are all of one size, and are rather wide. The internal longitudinal bars are broad and ribbon-like, and bound rather wide series of meshes, of which there are three rows in each interspace. Each mesh contains six or seven stigmata, and occasionally narrow transverse bars are present, crossing them for short distances. The tentacles are numerous and very delicate. Each of the polycarps on the inner surface of the mantle is somewhat flask-shaped (Pl. XXII. fig. 3, *g.*), and has a funnel-like duct at the narrower end. The walls of this genital mass contain scattered rod-shaped calcareous spicula (Pl. XXII. fig. 4, *sp.*), rather like those found in the test of *Cynthia complanata*.

One specimen of *Polycarpa minuta* was dredged in the Antarctic Ocean (to the south of Kerguelen Island), at Station 150; February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bottom temperature, 1°·8 C.; bottom, rock.

Polycarpa molguloides, Herdman (Pl. XXII. figs. 5–7).

Polycarpa molguloides, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 76.

External Appearance.—The body is transversely ovate, or sub-cylindrical; it is elongated dorso-ventrally and depressed; and is attached by the wide posterior end. The apertures are distant, they are both on the anterior end (upper surface), and are inconspicuous.

The surface is entirely covered by a thick layer of sand, shells, &c. The colour is dark brown.

Length (antero-posterior), 3 cm.; breadth (dorso-ventral), 7 cm.; thickness (lateral), 4 cm.

The Test is moderately thick and leathery; it is covered with branched hair-like processes, to which the sand-grains, &c., are attached.

The Mantle adheres closely to the test; it is thick and rough, and the musculature is feeble.

The Branchial Sac has four folds upon each side. The transverse vessels are nearly all of one size, but occasionally a larger one is met with. There are six internal longitudinal bars on the folds, and four in the interspaces. The meshes are transversely elongated, and contain each twelve stigmata.

The Dorsal Lamina is a plain membrane.

The Tentacles are numerous and crowded; they are all of one length, and are of a dark brown colour.

This is a very remarkable species, and is exactly like a *Molgula* in external appearance (Pl. XXII. fig. 5), the body being entirely covered with a thick coating of sand and

shell fragments. The shape also is peculiar. It is much elongated dorso-ventrally, and is depressed so as to form a transversely elongated sausage-shaped body.

The test also is like that of most species of *Molgula*, in being prolonged into branched hair-like processes, to which the sand is attached. The branchial sac is strong, on account of the presence of numerous very wide internal longitudinal bars (Pl. XXII. figs. 6 and 7, *i.l.*). Most of the transverse vessels are very narrow, but occasionally one meets with one which is considerably wider. The meshes in the interspaces are transversely elongated, and contain each about a dozen rather narrow stigmata. The whole branchial sac, and the numerous tentacles, are of a dark brown colour.

The polycarps only project slightly, as they are imbedded in the thick mantle.

Two specimens of this curious species were dredged off East Moncœur Island in Bass Strait, at Station 162; April 2, 1874; depth, 38 to 40 fathoms; bottom, sand.

Polycarpa quadrata, Herdman (Pl. XXII. figs. 8 10).

Polycarpa quadrata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 78.

External Appearance.—The body is oblong or oval in shape, erect and somewhat compressed laterally; both ends are broad and rounded, and the dorsal and ventral edges are nearly straight and parallel. The body is attached chiefly by the posterior end. The branchial aperture is terminal, sessile, inconspicuous and minute, the atrial is on the dorsal edge, more than one-third of the way from the anterior to the posterior end, it also is minute and inconspicuous.

The surface is considerably creased in all directions, especially round the apertures. The colour is dirty white.

Length of the body, 2 cm.; breadth of the body, 1·6 cm.

The Test is not thick, it is tough and strong, but not stiff, and is white and glistening on the inner surface.

The Mantle is very thin, and adheres closely to the test.

The Branchial Sac has four slight folds upon each side, and in these places the internal longitudinal bars are very numerous and close. The meshes are elongated antero-posteriorly, and are usually divided by a narrow transverse membrane, and each contains from one to four stigmata.

The Dorsal Lamina is a plain membrane.

The Tentacles are simple.

The Dorsal Tubercle is ovate in outline; it is very minute, and is placed at the posterior end of a deep peritubercular area.

This species has the typical Cynthiad appearance (Pl. XXII. fig. 8). The test is thick but tough, is not covered with sand, and is of a dirty white colour. The apertures are minute, and are both cross-slit (see atrial aperture in Pl. XXII. fig. 8).

The folds in the branchial sac are formed merely by the approximation of internal longitudinal bars, which are very numerous, but not wide (Pl. XXII. figs. 9 and 10, *i.l.*). The transverse vessels are of two sizes, and three of the smaller size occur between two larger ones. The meshes are elongated antero-posteriorly, and are usually divided by a narrow horizontal membrane attached to each fine interstigmatic vessel where they intersect (Pl. XXII. fig. 10, *h.m.*).

The dorsal tubercle, which is ovate in outline and very small, is situated at the foot of the deep peritubercular area. The intestine forms a wide loop. The polycarps are few, only three or four apparently upon each side of the body. The endocarps, however, are very numerous.

In some respects this species shows affinities with certain species of *Styela* (*e.g.*, *Styela glans*, *Styela oblonga*, and *Styela flava*), but it is quite distinct from them all; and although the polycarps are few, the intestinal curve is like that of a *Polycarpa*.

Three specimens of this species were discovered adhering to the clumps of spicules projecting from the sides of a large Hexactinellid sponge. They differ somewhat in external form, probably on account of their mode of attachment.

The locality is off Ki Island, in the Malay Archipelago, at Station 192; September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; depth, 129 fathoms; bottom, mud.

Polycarpa pilella, Herdman (Pl. XXII. figs. 11–15).

Polycarpa pilella, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 73.

External Appearance.—The body is a little variable in shape, but is generally spherical or ellipsoidal, occasionally rather pyriform, the posterior end being the narrower of the two; it is not compressed, and is erect; the anterior end is wide and convex, and the body is attached by the posterior end. The apertures are both at the anterior end; they are moderately far apart, and are not conspicuous.

The surface is entirely covered by a layer of sand. The colour is yellowish-brown.

Length of the body, 6 mm.; breadth of the body, 4 mm.

The Test is thin, but strong.

The Mantle is rather strong. The muscular fibres are delicate, but very numerous, forming a close network.

The Branchial Sac has four folds upon each side. The transverse vessels are all equal in size. There are about eight internal longitudinal bars on the folds, and the same number in the interspaces. The meshes are elongated antero-posteriorly, and contain each three stigmata.

The Dorsal Lamina is a plain membrane with an irregular edge.

The Tentacles are filiform; there are about twenty large ones, with one or two smaller between each pair of larger ones.

The Dorsal Tubercle appears to be very variable in shape.

This is the smallest species of Simple Ascidian in the collection, and is probably the smallest species known, with the exception of species of the genus *Perophora*. The surface is entirely covered with a fine coating of sand, so that the body looks simply like a little rounded pellet of sand (Pl. XXII. fig. 11).

The branchial sac is delicate (Pl. XXII. fig. 12), and the internal longitudinal bars are especially slender, but they are numerous. The usual meshes are elongated antero-posteriorly, and contain each three stigmata, but at the right side of the dorsal lamina there is a much wider series of meshes, which contain each about nine stigmata (Pl. XXII. fig. 12). Many of the rows of meshes are divided transversely by delicate membranes.

The dorsal lamina is not ribbed, but the edge is irregular and slightly toothed here and there (Pl. XXII. fig. 12, *d.l.*). The simple filiform tentacles are of about four sizes. There are about twenty of the two largest sizes placed alternately, and between every two of these are two, three or four of the two smaller sizes placed irregularly (Pl. XXII. fig. 13, *tn.* and *tn.'*).

The dorsal tubercle appears very variable. In one specimen examined it was irregularly horse-shoe shaped, with both horns rolled inwards; while in another specimen it was much simpler, being merely an antero-posteriorly elongated aperture, with two slight lateral diverticula (Pl. XXII. figs. 13 and 14, *d.t.*). It is very large, extending across the præbranchial zone to the tentacles, the edges of the aperture being bounded by columnar ciliated epithelium (fig. 14, *d.t.'*). There is a large rounded neural mass placed just behind the apex of the peritubercular area, and formed chiefly of the subneural gland (Pl. XXII. fig. 13, *gl.n.*). The præbranchial zone is rather broad and is semi-transparent, showing the circular and longitudinal muscle bundles of the mantle very distinctly (Pl. XXII. fig. 13, *z.*).

The course of the alimentary canal is shown in figure 15, Plate XXII. The œsophagus is short and curved, and opens into a globular stomach (*st.*), from which the intestine curves ventrally and then anteriorly (*i.*). It does not then turn back posteriorly, but slants across dorsally and anteriorly, to reach the neighbourhood of the atrial aperture. The anus, which is not distant from the œsophageal aperture, has an undulating edge (Pl. XXII. fig. 15, *a.*).

About a dozen specimens of this small species were obtained at Bahia, Brazil, in from 7 to 20 fathoms.

Polycarpa rigida, Herdman (Pl. XXIII. figs. 1–2).

Polycarpa rigida, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 76.

External Appearance.—The body is oblong and erect, with the anterior end pointed and the dorsal and ventral edges nearly straight and parallel. The posterior end is nearly straight, and is moderately wide, forming the point of attachment. The branchial aperture

is terminal and projecting, while the atrial is on the dorsal edge, fully one-third of the way from the anterior to the posterior end, and projecting. Both are very indistinctly lobed.

The surface is even but roughish, and partly covered by foreign bodies. The colour is a dull greyish-brown, but dull yellow round the apertures.

Length of the body, 8 cm.; breadth of the body, 3 cm.

The Test is not very thick and not tough, but is very stiff, like cardboard. It is white on section and on the inner surface.

The Mantle is thin, and adheres closely to the test; the musculature is feeble.

The Branchial Sac has four folds upon each side. The transverse vessels are of two sizes, about twelve narrow ones being placed between every two larger ones. There are about twelve internal longitudinal bars on the folds, and six in the interspaces. The meshes are transversely elongated, and contain twelve stigmata each.

The Dorsal Lamina is a narrow plain membrane, with the edge even.

The Tentacles are simple and closely placed; they are stout, and about forty in number, all of one length.

The Dorsal Tubercle is oblong, lies in a very large triangular perituberculer area, and is directed forwards and to the left.

This is a very large species to belong to the genus *Polycarpa*. It stands erect, attached by the posterior end, and having the branchial aperture uppermost (Pl. XXIII. fig. 1). The test, though not thick, is very stiff, and has a few shell fragments and other foreign matter adhering.

The branchial sac is strong, and has very wide internal longitudinal bars (Pl. XXIII. fig. 2, *i.l.*). These are numerous, and form well developed folds. In the interspaces the meshes are transversely elongated. The larger size of transverse vessel is very wide, as wide as one of the rows of stigmata. This sac is somewhat irregular in parts, and in two places in the portion figured (Pl. XXIII. fig. 2) the passage of one row of stigmata into two rows is seen. In the middle of the lower edge of the figure some of the stigmata are reduced to very small oval or rounded apertures. The tentacles are large, are all of one length, and are crowded together.

The intestine forms a very wide loop. The polycarps are deeply imbedded in the mantle, and hence only project slightly. In the genital masses some of the mature ova, which were incidentally examined, had each several distinct germinal spots.

Two specimens of *Polycarpa rigida* were obtained off East Moncœur Island, in Bass Strait, at Station 162; April 2, 1874; depth, 38 to 40 fathoms; bottom, sand.

Polycarpa longisiphonica, Herdman (Pl. XXIII. figs. 3–6).

Polycarpa longisiphonica, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 77.

External Appearance.—The body is oblong, or somewhat flask-shaped, and erect. The posterior end is large and rounded, the anterior end narrow and pointed. It is apparently not attached, or only slightly by the posterior third of the left side. The apertures are conspicuous, at the ends of very long siphons; the branchial is terminal, and is directed anteriorly; the atrial is on the dorsal edge, half way down, and is directed dorsally and anteriorly; it is fully as long as the branchial siphon.

The surface is covered, except on the siphons, by a fine coating of sand and shell fragments. The colour is a dark brown.

Length of the body, 7 cm.; breadth of the body, 4 cm.

The Test is thin and brittle, but rather stiff.

The Mantle is thin, and adheres closely to the test. The musculature is feeble.

The Branchial Sac has four folds upon each side. Every fifth or sixth transverse vessel is wider than the intermediate ones, which are all of one size. There are eight internal longitudinal bars on the folds, and about the same number in the interspaces. The meshes are square, they contain each four to six stigmata, and are occasionally divided by a narrow horizontal membrane.

The Dorsal Lamina is a narrow and plain-edged membrane.

The Tentacles are not very long, and are placed rather far apart. There are about eighteen, some shorter than others, but not placed symmetrically.

The Dorsal Tubercle is circular in outline, or somewhat horse-shoe-shaped, with both ends turned slightly outwards.

This species resembles *Polycarpa rigida* in its erect body and stiff test, partly covered with adhering foreign matter (Pl. XXIII. fig. 3). If attached at all, it is only slightly so by the posterior part of the left side. The length of the siphons upon which the apertures are placed is a characteristic feature.

As in the last species, the transverse vessels are of two sizes (Pl. XXIII. fig. 4, *tr.* and *tr.'*), but here the internal longitudinal bars are narrow, and not wide as in *Polycarpa rigida*. The interspaces are wide, and have each about eight rows of meshes. The internal longitudinal bars are crowded on the folds. In one of the specimens of this species all the vessels in the sac appear to be rather wider. The ordinary meshes in the interspaces are square, or a little elongated transversely, and are occasionally divided by narrow horizontal membranes.

The tentacles are of different sizes, but these are not arranged symmetrically. In one specimen examined there were about sixteen larger tentacles and two or three very small ones between each pair of larger. There is a double line of columnar cells (probably ciliated when living) running down the anterior face of each tentacle, and becoming

continuous at the apex (Pl. XXIII. figs. 5 and 6). The polycarps are numerous and large, and of a yellow colour.

Three specimens of this species were found at Port Jackson, Australia, in from 6 to 15 fathoms.

Polycarpa irregularis, Herdman (Pl. XXIII. figs. 7 and 8).

Polycarpa irregularis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 72.

External Appearance.—The body is irregularly oblong, somewhat pyriform, erect, and rather compressed laterally. The anterior and posterior ends are narrow, and the middle two-fourths are wide, and have the dorsal and ventral edges parallel; the ventral edge is straight throughout; the dorsal slopes in its anterior and posterior fourths, but is straight in its central two-fourths. The body is attached by the narrow but irregular posterior end. The branchial aperture is terminal and prominent, and is surrounded by four large lobes and four small ones; the atrial is on the dorsal edge, rather more than one quarter of the way down; it is distinct.

The surface is very irregular; it is cut up by deep grooves and folds, and is partially covered by foreign bodies. The colour is a dirty yellowish-white.

Length of the body, 6 cm.; breadth of the body, 3·5 cm.

The Test is rather thick and tough; it is white and glistening on the inner surface.

The Mantle is thin, and the musculature is not strong.

The Branchial Sac has four folds upon each side. There are two or three narrow transverse vessels between each pair of wider ones. About eight internal longitudinal bars are present on the folds, and twelve in the interspaces. The meshes are transversely elongated, and contain each six stigmata.

The Dorsal Lamina is narrow and smooth.

The Tentacles are linear and rather distant; they are twenty-four in number, and are coloured black; some are rather smaller than the others, but are not placed alternately.

The Dorsal Tubercle is ovate in shape, but has the narrow end placed posteriorly; it is much convoluted and marked with black.

The surface of this large *Polycarpa* is curiously irregular (Pl. XXIII. fig. 7), especially at the posterior end. The test is thick and tough, and of a yellowish-white colour. The apertures are both distinct. The branchial has eight lobes, but four of them are large, while the others are merely intermediate smaller processes or folds.

In the branchial sac there are two distinct sizes of transverse vessels. Each pair of larger ones is separated by either three or, more rarely, two smaller ones (Pl. XXIII. fig. 8). The stigmata are small, and show a considerable amount of irregularity. Horizontal membranes are not much developed.

The intestine forms a wide loop. The yellow endocarps are numerous, but rather small.

One specimen of this species was dredged at the Philippine Islands, at Station 208; January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; depth, 18 fathoms; bottom, mud.

Polycarpa sulcata, Herdman (Pl. XXIII. figs. 9–13).

Polycarpa sulcata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 73.

External Appearance.—The body is between ovate and pyramidal in shape, and is not compressed. The anterior end is narrow, but rounded; the posterior end is broad and rounded; the ventral edge is very convex, while the dorsal is convex posteriorly and concave anteriorly. The body is attached by the posterior end of the ventral edge. The branchial aperture is not terminal, but is twisted round to the dorsal edge; it is prominent, and is directed dorsally. The atrial is on the dorsal edge, about half-way from the anterior to the posterior end, and directed dorsally. Both are four-lobed, wide and conspicuous.

The surface is smooth but uneven; it is cut up by deep creases and folds into rounded pad-like projections. The colour is a dull creamy-white.

Length of the body, 5·5 cm.; breadth of the body, 3·5 cm.

The Test is thick and tough, but soft and not stiff. The inner surface is white, with small dark dots over it.

The Mantle is thin, does not adhere to the test, and is of a dark brown colour; the musculature is not strong.

The Branchial Sac has four narrow folds upon each side. Three narrow transverse vessels are usually present between each pair of wider ones. The internal longitudinal bars are few. The meshes are transversely elongated, and contain each about eight to twelve stigmata.

The Dorsal Lamina is smooth, and very narrow.

The Tentacles consist of twelve rather large, but not very long, distantly placed ones, with two or three very minute ones between each pair of the former.

The Dorsal Tubercle is large and irregular, with a spongy appearance.

This species has a very peculiar external appearance (Pl. XXIII. figs. 9 and 10). The anterior end appears to have been bent over, so that the branchial aperture comes to be directed dorsally. Both apertures are wide and square. The test is thick and tough, but rather soft, and is raised up on its external surface into a number of large rounded knobs and ridges. In minute structure the test is composed of a finely and closely fibrillated matrix, having somewhat the appearance of close felt (Pl. XXIII. fig. 13, *t.m.*), and in this are scattered here and there large hollow spaces or vessels containing blood corpuscles. These form the small dark dots which are seen with the naked eye scattered

over the inner white surface of the test, and they are merely cavities in connection with the blood-vessels, which may also be seen here and there in sections. A number of smaller blood cavities are present just below the outer surface of the test, recalling the arrangement in *Culeolus*, but the larger vesicles are always more deeply placed (Pl. XXIII. fig. 13).

The folds in the branchial sac are narrow, and the internal longitudinal bars are slender. The arrangement of the transverse vessels is shown on figure 11, Plate XXIII.; above the large transverse vessel (*tr.*) two rows of stigmata are seen passing into one. In some parts of the sac the stigmata are longer and narrower than in the part figured. On account of the fewness of the internal longitudinal bars, the meshes are much elongated transversely. Muscle fibres are seen well in some of the vessels of this branchial sac (Pl. XXIII. fig. 12).

Three specimens of *Polycarpa sulcata* were dredged off Banda, in the Moluccas; depth, 17 fathoms.

Polycarpa pedata, Herdman (Pl. XXIV. figs. 1 and 2).

Polycarpa pedata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 71.

External Appearance.—This species is irregularly club-shaped, and consists of a long stalk supporting a somewhat globular body produced anteriorly. The posterior end of the body is broad and rounded, and passes rapidly into the narrow stalk, which is nearly as long as the body. The ventral edge is nearly straight; the dorsal is strongly convex in its posterior half, and straight in the anterior part. The animal is attached by the extremity of the long narrow stalk. The branchial aperture is terminal, it is very prominent, and is directed anteriorly; the atrial is on the dorsal edge, about half way down the body; it projects, and is directed anteriorly and dorsally; both are distinctly four-cleft.

The surface is smooth, but grooved and creased somewhat. The colour is yellowish-white, with a tinge of red on the stalk.

Length of the body (total), 10·5 cm.; breadth of the body, 4 cm.

The Test is thin but tough.

The Mantle is moderately thick, but adheres here and there to the test; the musculature is close but not strong.

The Branchial Sac has four folds upon each side. The transverse vessels are all of one size. The internal longitudinal bars are numerous. The meshes are slightly elongated transversely, and contain each five or six stigmata.

The Dorsal Lamina is a plain membrane.

The Tentacles are long and of a brown colour. There are twenty-five of them, and they are all of one length.

This is a very remarkably shaped animal (Pl. XXIV. fig. 1). The body is somewhat globular, with an anterior process containing the branchial siphon, and is supported upon a stalk, which, however, is clearly a mere process of the posterior end. This stalk is about as long as the body, and is curved round ventrally. The apertures are both prominent and distinctly four-cleft (Pl. XXIV. fig. 1). The surface is considerably grooved and ridged, but otherwise smooth; it has a yellowish-white colour.

The branchial sac presents a curious appearance in the single specimen known, from the circumstance that all the vessels are engorged with blood corpuscles, thus forming a natural injection. Most of the transverse vessels are of the same size (Pl. XXIV. fig. 2), but occasionally a larger one is met with. The meshes are slightly elongated transversely, and are rarely divided by a horizontal membrane.

The margin of the anus is cleft into a series of processes. The atrial siphon has at its base a diaphragm, which has its free edge finely fringed. The polycarps are large; tentacular endocarps are also present.

One specimen of *Polycarpa pedata* was dredged near the Philippine Islands, at Station 212; January 30, 1875; lat. 6° 55′ N., long. 122° 15′ E.; depth, 10 to 20 fathoms; bottom, sand.

Polycarpa radicata, Herdman (Pl. XXIV. figs. 3–5).

Polycarpa radicata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880–81, p. 75.

External Appearance.—This species is club-shaped and erect, consisting of a globular body, supported on a narrow stalk equalling the body in length. The anterior end is rather broader than the posterior, which is continuous with the stalk; the edges are convex. The stalk is long and narrow, and spreads out somewhat at the lower end, where it is attached. The apertures are both at the anterior end, they are sessile and inconspicuous, with the lobes indistinct. The branchial is on the ventral edge of the anterior end, while the atrial is about the centre, and is slightly the more anterior of the two.

The surface is even, but slightly sandy. The colour is a dull greyish-yellow.

Length (total), 3·5 cm.; breadth of the body, 1·7 cm.; length of the body, 2 cm.

The Test is moderately thick and strong, but not stiff.

The Mantle is closely united to the test, and is thin.

The Branchial Sac has four folds upon each side. There are three narrow transverse vessels between each pair of wide ones. The internal longitudinal bars are ribbon-like, they are close and numerous on the fold, but few in the interspaces. The meshes are transversely elongated, and contain each six to twelve stigmata.

The Dorsal Lamina is narrow.

The Tentacles are simple and numerous; there are about fifty, crowded together; they are of different sizes, but do not alternate.

The Dorsal Tubercle is circular or slightly elongated transversely, one end is turned out and one turned in.

This is a curiously shaped little species, and like *Polycarpa pedata* has the posterior end of the body prolonged to form a peduncle (Pl. XXIV. figs. 3 and 4). The lower end of the peduncle gives off a number of fine prolongations or rootlets, by means of which the animal is attached.

The test is rather thick and strong, is not irregular on the surface, but has sand grains attached here and there. The folds in the branchial sac are well marked, and have the internal longitudinal bars closely placed, while in the interspaces they are few and distant (Pl. XXIV. fig. 5); consequently the meshes are wide, and contain mostly ten or twelve stigmata. The transverse vessels are of two sizes, arranged so that three smaller and one larger alternate. The tentacles are numerous and closely crowded. There are numerous yellow polycarps present.

In external appearance this species is not unlike *Polycarpa pedunculata*, Heller,[1] but is much smaller, and differs in several details of internal structure, such as the number of tentacles.

Two specimens of this species were collected, both in Australia. One is from Port Jackson, depth, 6 fathoms; the other was trawled off Twofold Bay, south-east coast of Australia, at Station 163; April 4, 1874; depth, 120 fathoms.

Family Ascidiidæ.

Body fixed; usually sessile, rarely stalked.

Test cartilaginous or gelatinous, rarely chitinous. Branchial aperture usually eight-lobed; atrial aperture usually six-lobed.

Branchial Sac not folded; internal longitudinal bars present, and usually papillated; stigmata straight or curved.

Tentacles simple, filiform.

Intestine either placed at one side of the branchial sac, or extending beyond it posteriorly.

Genitalia always in close connection with the alimentary canal.

This is a very compact family, its only close allies being the Clavelinidæ, from which it is sharply defined by its want of the property of budding. From the other two families, the Molgulidæ and the Cynthiidæ, it is distinguished by its branchial sac not being disposed in folds. The remaining characteristics given above, though none of them alone would sufficiently define the family, are all of importance, and when taken collectively separate the Ascidiidæ from other Simple Ascidians.

[1] Beiträge zur nähern Kenntniss der Tunicaten, p. 24.

The body is always fixed, usually by the posterior end and more or less of the left side; it is in almost all cases sessile, and when not so the stalk is merely a narrow prolongation of the posterior end, and is not comparable with the peduncle of the Bolteninæ. The test is usually cartilaginous or gelatinous, and is found in all stages between these two conditions. In the genus *Chelyosoma*, an aberrant form, it is developed into horny plates. The number of lobes surrounding the apertures may vary considerably. In the majority of cases it is—branchial eight-lobed, atrial six-lobed, but the branchial is frequently found with seven or with nine lobes, while in *Chelyosoma* it is only six-lobed; in *Abyssascidia*, on the other hand, the branchial aperture is surrounded by fourteen lobes, and the atrial aperture by nine. The musculature of the mantle is generally very irregular, but in the genus *Ciona* a series of conspicuous longitudinally running bands are formed.

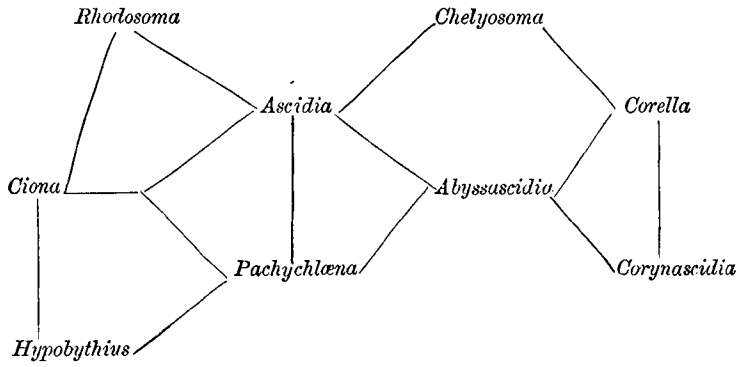
The branchial sac is never folded, but in many species of *Ascidia* it is thrown into a series of minute longitudinal plications, which will be described in detail further on. These must not be confused with the conspicuous folds so characteristic of the Cynthiidæ and the Molgulidæ, which are entirely wanting in the present family. The internal longitudinal bars, which are almost invariably present, are in the form of more or less stout, rounded bars, in contrast to the ribbon-like vessels found in many of the Cynthiidæ and some of the Molgulidæ. Usually in the Ascidiidæ the bars bear on their inner sides papillæ, varying in size, shape, number and arrangement according to the genus and species. The stigmata are straight and approximately parallel, except in the genera *Corella*, *Corynascidia* and *Chelyosoma*, where they are curved and arranged spirally round certain central points. The tentacles are invariably simple, elongated, tapering filaments, like those of the Styelinæ, but usually rather thinner.

The arrangement of the viscera varies considerably. In most forms, including the genus *Ascidia*, the stomach and intestine lie upon the left side of the branchial sac; but in the nearly allied *Ciona*, they extend considerably beyond the branchial sac posteriorly, so as to form a rudimentary abdomen. In *Corella* and *Abyssascidia*, again, the stomach, intestine, and heart are placed upon the right side of the branchial sac, and the course of the intestine is different from that found in *Ascidia*.

The genital glands are always found in close relation with the alimentary canal, generally applied to the wall of the posterior part of the stomach, or the first part of the intestine, and often occupying the intestinal loop; they are never found attached to the mantle independently of, and at a distance from, the intestine, as is so frequently the case in the Cynthiidæ and the Molgulidæ.

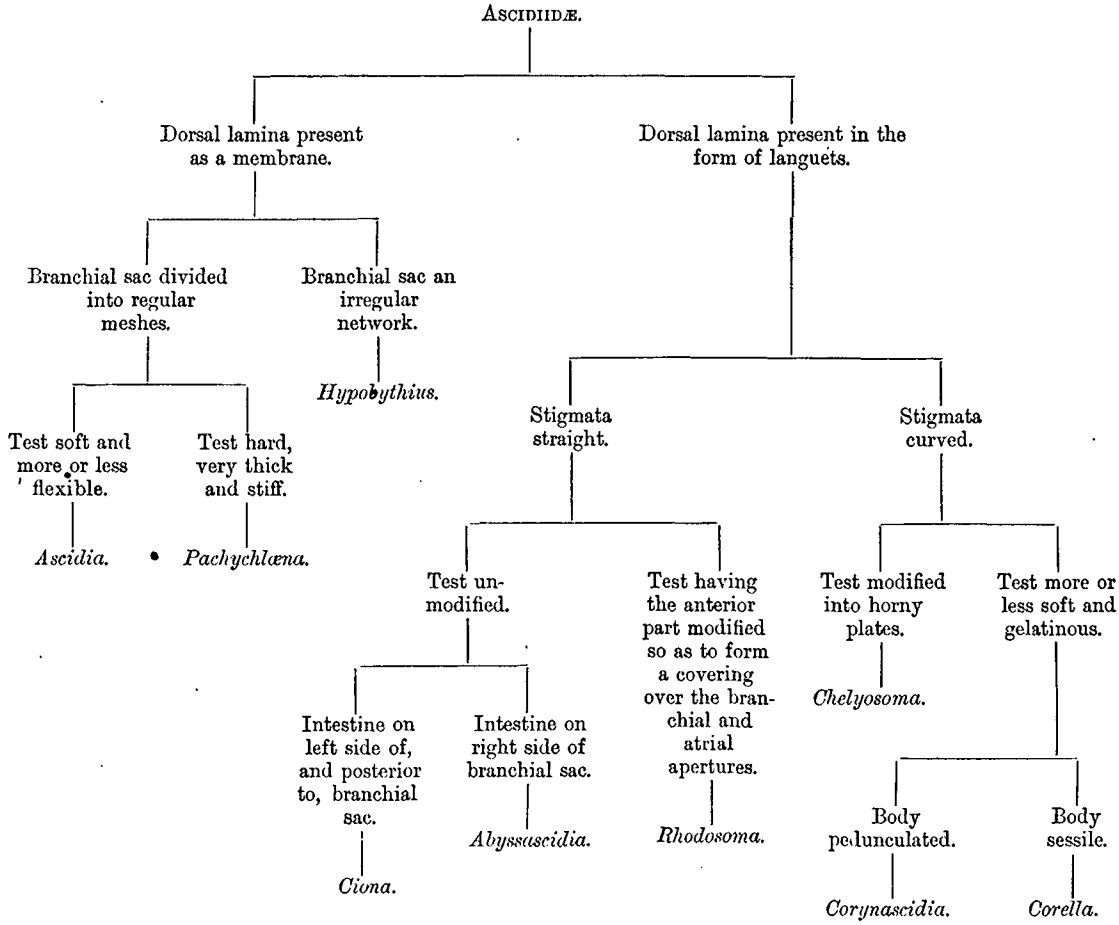
The genus *Ascidia* is, even in its modern restricted sense, the typical and most important genus of this family. It contains by far the largest number of species, and is a central point round which the other genera may be arranged, according to their affinities. The first of these is *Pachychlæna*; this form and *Ascidia* are more closely allied than any other two of the genera. At the one extreme end of the series of which *Ascidia*

and *Pachychlæna* occupy the centre, may be placed *Ciona*, leading towards the Clavelinidæ, while two genera, *Corella* and *Corynascidia*, occupy the opposite end. *Abyssascidia* comes in between *Ascidia* and *Corella*, while the two somewhat aberrant forms, *Rhodosoma* and *Chelyosoma*, must be considered as allied, the former to *Ascidia* and *Ciona*, and the latter to *Ascidia* and *Corella*, but both having marked peculiarities of their own, which prevent their being placed in the direct line between their allies. The remaining form, *Hypobythius*, is in some respects (*e.g.*, the structure of the branchial sac) the most abnormal of all. It is allied to *Ciona*, and has also affinities with *Ascidia* or *Pachychlæna*, but cannot be placed in a direct line between them. These relationships may be shown in a schematic form thus :—

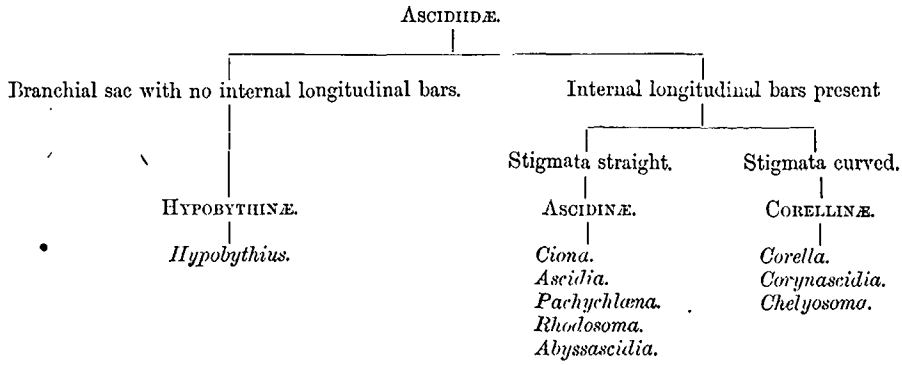


This scheme might be divided by two vertical lines, so as to separate three groups,—a central, containing *Ascidia* and *Pachychlæna*, and two lateral, the one containing *Corella, Corynascidia, Chelyosoma*, and *Abyssascidia ;* and the other the three remaining genera, *Ciona* and the two abnormal forms *Rhodosoma* and *Hypobythius.*

The table immediately following shows how these nine genera may be distinguished by a few of their more important characters. It seems impossible, however, to arrange them satisfactorily in sub-families. For example, the first division in this table, founded on the condition of the dorsal lamina, throws *Ciona* in contact with *Corella*, and separates it from the much more nearly allied *Hypobythius.* In other respects, however, this table is not an unnatural arrangement; it brings *Abyssascidia, Corynascidia*, and *Corella* into the same section, and puts *Pachychlæna* and *Ascidia* into close contact.



The family may be broken up, as seen below, into three groups according to the structure of the branchial sac, but this is not altogether satisfactory, since it involves the separation of *Abyssascidia* from its near allies *Corella* and *Corynascidia*; otherwise it seems the most natural arrangement possible.



The Challenger collection contains representatives of all these genera, with the exception of *Rhodosoma* and *Chelyosoma*. Four of the remaining seven, namely, *Hypobythius*, *Pachychlæna*, *Abyssascidia* and *Corynascidia* have been founded for the reception of new forms obtained during the expedition.

Corynascidia, n. gen.

External Appearance.—Shape elongated, pyriform, pedunculated; apertures not lobed.

Test gelatinous or membranous.

Branchial Sac extremely delicate. Internal longitudinal bars present, but not provided with papillæ. Interstigmatic vessels coiled spirally.

Dorsal Lamina in the form of languets.

Tentacles simple, filiform.

Viscera on dorsal edge of branchial sac, running antero-posteriorly.

This curious genus is closely allied to *Corella*, but is so different from it in many particulars as to necessitate the formation of a new genus. Its greatest peculiarities are the pyriform pedunculated body, the delicate spirally coiled vessels in the branchial sac, and the form and position of the viscera. Further remarks on its structure and affinities will be given at the end of the description of the single species known.

Corynascidia suhmi, n. sp. (Pl. XXV.).

External Appearance.—The shape is pyriform, and consists of a body which is flattened laterally, and a long stalk. The body is elongated, and the anterior and dorsal ends are short, while the ventral and posterior are greatly elongated, so as to produce a triangular shape. The stalk is about as long as the body, and is very thin where it joins the body at the ventral edge of the posterior end. It gradually increases in width as it runs backwards, till at the point of attachment it is three times its original breadth. The apertures are not lobed; they are rather wide, and slightly projecting; the branchial is at the ventral edge of the anterior end, and is directed anteriorly and ventrally; the atrial is at the dorsal edge, and is directed dorsally. There is a deep depression in the middle of the dorsal edge, just opposite the stalk.

The surface is smooth and pretty even. Some parts of the body are finely creased longitudinally. The surface of the stalk is smooth and glistening. The colour is dirty grey, with a yellowish tinge on parts of the body.

Length of the body (dorso-ventral), 7 cm.; breadth of the body (antero-posterior), 3·2 cm.; length of the stalk, 7·5 cm.

The Test is between membranous and gelatinous in consistency; it is thin and semi-transparent.

The Mantle is very thin, and the musculature is slight. It extends for a short distance into the upper end of the long peduncle.

The Branchial Sac is extremely delicate and filmy; all the vessels are very narrow. The transverse vessels are all of about the same size, and are connected by longitudinal ducts, so as to form square meshes, in which the secondary or interstigmatic vessels are coiled spirally, as in *Corella;* each spiral has about three turns. Internal longitudinal bars are present, but are not papillated; they are borne on long triangular connecting ducts.

The Dorsal Lamina is represented by long triangular languets.

The Tentacles are filiform, and are very long and thin; they are numerous, arranged rather closely, and are of two sizes, placed alternately larger and smaller.

The Dorsal Tubercle is irregularly oval in outline. The aperture is anterior and narrow, and the horns almost meet.

The Viscera are relatively of small size, compact, and form a narrow band running antero-posteriorly along the dorsal edge of the branchial sac.

This remarkable form seems to be a deep-sea representative of *Corella,* and is also allied to *Ascidia* and *Pachychlæna* through *Abyssascidia.* It is, however, quite distinct from any of these genera.

The dimensions given above are those of the specimen from Station 299. Of the two others, from Station 146, the perfect specimen is smaller, while the injured one was apparently much larger. Their dimensions are as follows:—

	A.	B.
Length of the body,	about 5 cm.	about 8 cm.
Greatest breadth of the body,	about 2·5 cm.	about 5 cm.
Breadth of the body at posterior end,	0·8 cm.	
Length of the stalk,	5 cm.	stalk absent.

The shape is remarkable. It is the only known stalked form among the Ascidiidæ, and is much more like an abnormal Molgulid. The body is pear-shaped, the ventral and posterior sides being pulled out so as to form a long tapering process, which becomes continuous with the stalk (Pl. XXV. fig. 1). The apertures are situated at the two extremities of the anterior end, and are wide and tubular, but devoid of lobes.

The stalk is smooth and glistening, it is rather tougher looking than the rest of the test, and widens as it recedes from the body to its point of attachment to a manganese nodule (Pl. XXV. fig. 1). The upper narrow part of the stalk is twisted in one of the specimens.

The mantle is thin and membranous, with only a few distant muscle bands radiating

through it. The muscle bands end abruptly by dividing each into two or three conical processes, which suddenly taper off in the manner so characteristic of the muscle bands in the genus *Corella*, and also, as will be seen below, of those in the mantle of *Abyssascidia wyvillii*.

The branchial sac is the most striking form known in the Ascidiidæ, and has a very remarkable shape, its ventral, and especially its posterior, edges being greatly prolonged, so that its posterior end comes to be much the widest part (Pl. XXV. fig. 2). It is wonderfully delicate and somewhat like a spider's web. The regularly arranged transverse vessels are united by very narrow longitudinal tubes (Pl. XXV. fig. 6, *w.l.*), so as to form large squares in which the spirals are placed. All the vessels are very thin, with wide spaces between them, and the spirals are converted into either squares or polygons by the presence of four or more straight vessels radiating outwards from the centre of each of the spirals to the four corners, and sometimes to the sides of the circumscribed square (Pl. XXV. fig. 6, *r.v.* and *r.'v.*)

The internal longitudinal bars are very delicate, and are borne on the apices of long triangular membranous flaps or connecting ducts, which arise from the transverse vessels, but are connected by no horizontal membranes. These flaps arise at the corners of the squares (Pl. XXV. fig. 6, *c.d.*), and in the middles of their upper and lower sides; consequently an internal longitudinal bar runs across the middle of each square containing a spiral, and there are twice as many true meshes as there are of these squares. The true meshes (formed by the transverse vessels and the internal longitudinal bars) are elongated antero-posteriorly.

In the first specimen examined, the languets along the dorsal edge of the branchial sac were all of one size, triangular in shape, not long, and placed in a double row (Pl. XXV. fig. 7). In one of the other individuals, however, they were found to be much narrower and more elongated, of two distinct sizes, occurring alternately, and placed in a single row (Pl. XXV. fig. 8). The difference is considerable, but scarcely sufficient to warrant the establishment of a distinct species.

The numerous tentacles (Pl. XXV. fig. 5, *tn.* and *tn.'*) are very long and thin. The longer ones are as a rule about twice the length of the shorter ones. The endostyle is inconspicuous, and runs from the neighbourhood of the branchial aperture apparently only as far as the narrow end of the sac near the point of attachment of the peduncle (Pl. XXV. fig. 2, *en.*).

The alimentary and reproductive viscera are in many respects like those in the genera *Corella* and *Abyssascidia*. As in the latter genus, they are very small compared with the size of the body and of the branchial sac. They form a compact elongated mass, lying along the dorsal edge of the sac, and a little on its right side (Pl. XXV. fig. 2). The œsophagus opens at the dorsal edge, about one-half of the way down the branchial sac, and runs posteriorly for a short distance, and then opens into the narrower

anterior end of the pyriform and moderately capacious stomach (Pl. XXV. figs. 2 and 3, *st.*). The intestine emerges from the more globular posterior end of the stomach, and still runs posteriorly for a short distance, and then, having reached the posterior end of the mantle, turns abruptly on itself from the right to the left side (Pl. XXV. fig. 3, *i.*), and runs anteriorly in close contact with the stomach and œsophagus. It then with a slightly undulating course continues as the rectum (Pl. XXV. figs. 2 and 3, *r.*) up to the atrial aperture.

The genitalia (Pl. XXV. figs. 2 and 3, *g.*) form a single lobed mass covering the posterior half of the stomach and the commencement of the intestine, but not extending into the loop. The ducts course along the dorsal side of the intestine, and terminate like the anus just inside the atrial aperture (Pl. XXV. figs. 2 and 3, *g.d.*).

One specimen of this species was obtained between Juan Fernandez and Valparaiso, at Station 299; December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; depth, 2160 fathoms; bottom temperature, 1°·1 C.; grey mud; and two specimens, one considerably injured, were obtained between the Cape of Good Hope and Kerguelen Island, at Station 146; December 29, 1873; lat. 46° 46′ S., long. 45° 31′ E.; depth, 1375 fathoms; bottom temperature, 1°·5 C.; bottom, globigerina ooze.

Corella, Alder and Hancock.

Ascidia, O. F. Müller, Zoologia Danica, vol. ii. 1780. In part.
Ascidia, Forbes and Hanley, British Mollusca, vol. i. 1853. In part.
Ascidia, Alder, Observations on British Tunicata, Ann. and Mag. Nat. Hist., ser. iii. vol. ii. 1863. In part.
Corella, Hancock, On the larval state of *Molgula*, &c., Ann. and Mag. Nat. Hist., ser. iv. vol. vi. p. 362. 1870.
Corella, Kupffer, Jahresber. der Commiss. 1875.
Corella, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices. 1880.
Corella, Traustedt, Vestindiske Ascidiæ Simplices. 1881.

Body attached, sessile. Branchial aperture eight-lobed, atrial six-lobed.
Test cartilaginous, but soft and semi-transparent.
Branchial Sac not longitudinally plicated. Internal longitudinal bars present, but not papillated; stigmata curved; fine longitudinal vessels coiled spirally.
Dorsal Lamina represented by languets.
Tentacles simple.
Viscera placed upon the right side of the branchial sac.
Genitalia situated on the intestinal loop.

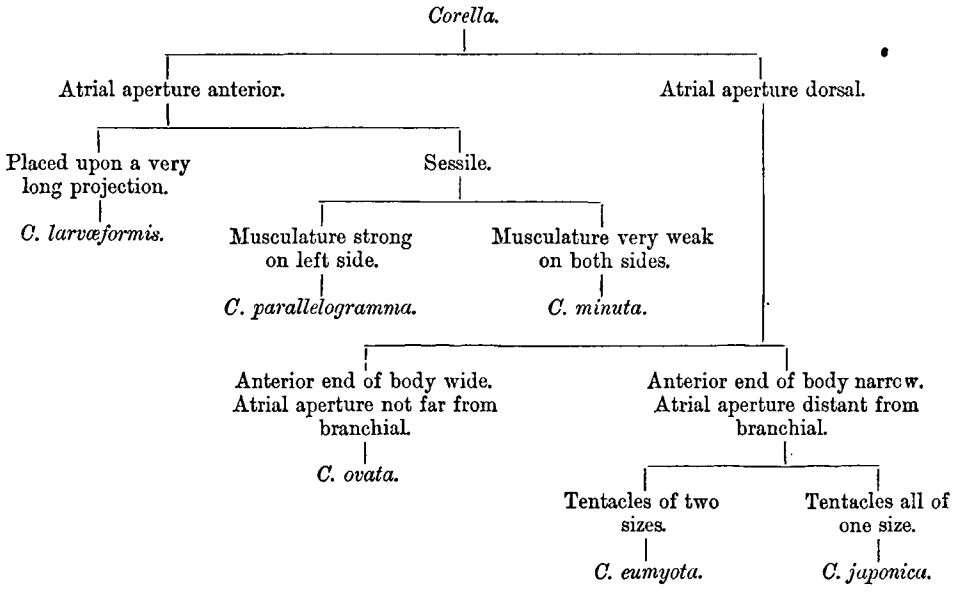
The species forming the genus *Corella*, although now universally admitted to be very distinct from those of *Ascidia*, were included in the latter genus until within the last twelve to fifteen years.

In 1863 Alder pointed out the more important characteristics of *Ascidia parallelo-*

gramma, O. F. Müller, and suggested that it should be separated from the other species of *Ascidia* as a new genus; but this was not formally done until Hancock, in 1870, published a paper in the Annals and Magazine of Natural History, containing descriptions of a large number of new species of British Tunicata, two of which, *Corella larvæformis* and *Corella ovata*, he referred to the newly-made genus. He defined the genus chiefly by the peculiarities which Alder had pointed out seven years before as distinguishing *Corella parallelogramma*, namely, the position and course of the alimentary canal, the position of the heart upon the right side of the branchial sac, and the spiral interstigmatic vessels.

The Challenger expedition added a third species (*Corella japonica*), from the Japanese Seas, and quite recently (1881), Traustedt has described two new species (*Corella minuta* and *Corella eumyota*) from the West Indies.

These different species may be distinguished according to the following table:—



Corella japonica, Herdman (Pl. XXVI.).

Corella japonica, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80., p. 472.

External Appearance.—The shape is ovate or longish ovate, the anterior end being narrower than the posterior, which is rounded; the ventral edge is rather more convex than the dorsal. The body is somewhat compressed laterally, and is attached by the posterior end and the posterior half of the lower or right side. The base is occasionally produced into short tufts for attachment. The branchial aperture is terminal or subterminal, being slightly on the left side of the anterior extremity. The atrial is about

one-third of the way from the anterior to the posterior end, and on the left side, not far from the dorsal edge. Both apertures are sessile and inconspicuous.

The surface is slightly rough, especially at the anterior end; it is generally prolonged here and there at the edges and the lower surface into fine hair-like branched processes. The colour is dull grey.

Length of the body, 3 cm.; breadth of the body, 1 cm.

The Test is thin, but moderately strong; no vessels are visible.

The Mantle is very delicate over most of the right side and half of the left, while on the anterior and dorsal edge of the right side, and the anterior half of the left side muscular bands are extraordinarily developed, and attain a great thickness (up to 0·3, and in one or two cases 0·5, mm.). The siphons are muscular and fairly prominent. The branchial aperture is provided with eight, and the atrial with six ring-shaped ocelli, of a light rust colour.

The Branchial Sac is not plicated. The transverse vessels are large and are all equal in size. They are joined by short wide longitudinal vessels, thus forming square meshes in which the spirally coiled secondary or interstigmatic vessels lie. Internal longitudinal bars are numerous, being in excess of the wide longitudinal vessels. They are delicate but distinct, and are united to the transverse vessels by wide horizontal membranes, which are present in the proportion of two or three to every transverse vessel. The stigmata are curved, and are placed spirally, in rows of square meshes separated by the transverse vessels. The stigmata near the outside of the mesh are usually crescentic, while those further in are longer and are coiled spirally.

The Dorsal Lamina is represented by a series of long tapering languets.

The Tentacles are very numerous, touching at their bases; they are all of one size, and are moderately long and filiform.

The Dorsal Tubercle is regular, the outline is between cordate and ovate, and both horns are coiled inwards.

The Alimentary Canal is moderately large, and is placed on the right side of the branchial sac. The stomach is nearly globular. The intestine is wide, and curves round ventrally and posteriorly to the stomach.

The Genitalia are on the first part of the intestine, and in the intestinal loop.

This species, which agrees in all generic characters with *Corella* as defined by Hancock in 1870, is the only species collected during the Challenger expedition which can be referred to that genus.

The general form of the body distinguishes this species clearly from *Corella parallelogramma*, O. F. Müller; *Corella minuta*, Traustedt; *Corella larvæformis*, Hancock; and *Corella ovata*, Hancock. It is more nearly allied to *Corella eumyota*, Traustedt, but may, I think, be distinguished from that species also by several details of structure. In *Corella*

japonica the atrial aperture is situated on the dorsal edge, only about one-third of the distance from the anterior to the posterior end, while in *Corella eumyota* it appears from Traustedt's figures to be about half-way down. In *Corella japonica* the musculature is very strongly developed along the dorsal part of the left side (Pl. XXVI. fig. 2, *m.b.*), while in *Corella eumyota* there is no such disproportionate development. The two species differ again in the structure of the branchial sac, as Traustedt's figures show a more irregular arrangement of the spirals than that found in *Corella japonica.*

The delicate branched processes of the test (Pl. XXVI. fig. 1) suggest the very similar structures so well known in the Molgulidæ, and in this case also sand grains are frequently found adhering to or entangled in them, though never in any quantity.

The very remarkable muscle bands seen in the mantle, especially on the left side just below the siphons (Pl. XXVI. fig. 2, *m.b.*), have a considerable resemblance to those found in *Abyssascidia wyvillii*, and are even thicker than in that species. In some places they terminate very abruptly (Pl. XXVI. fig. 6), their wide ends breaking up into a number of short thick pointed processes, which rapidly taper off to a fine extremity. The ocelli round the apertures are distinct. They are of a rust-red colour, and appear ring-shaped, possibly from the presence of a light yellowish spot in the centre of the red.

The branchial sac has the structure usually found in *Corella;* the transverse vessels and the longitudinal tubes connecting them are wide, while the internal longitudinal bars are very narrow, and are more numerous than the rows of spirals (Pl. XXVI. figs. 4 and 5). The horizontal membranes are wide, and are very numerous. They have frequently curved prolongations or connecting ducts which join the internal longitudinal bars in certain positions. These look as if they projected from the bars, and thus they gave rise to the erroneous statement in the description of this species in the Preliminary Report, that the internal longitudinal bars are provided with long curved papillæ. One other point in regard to the branchial sac must be noticed. In some places the internal longitudinal bars are very much broken up, as seen in figure 8. A bar may end cæcally close to its point of attachment to a horizontal membrane, and may begin again at the next membrane, leaving a gap between the two; it may then continue normally, or it may terminate again, in which case there will be a short piece of generally curled tube ending cæcally in both directions, and attached by the middle to a horizontal membrane (Pl. XXVI. fig. 8). This irregularity in the internal longitudinal bars may also be observed in *Corella parallelogramma* of our own coasts.

The languets along the dorsal edge of the sac are narrow and tapering; they are all of the same size, and are not placed closely (Pl. XXVI. fig. 7, *l.*). The tentacles are very closely packed, and are apparently all of the same size. The symmetrically-shaped dorsal tubercle (Pl. XXVI. fig. 9, *d.t.*) lies in a shallow triangular peritubercular area, and is separated by less than half its own height from the bases of the tentacles.

The viscera are in the position usual in the genus, namely, on the right side of the

branchial sac, and have the normal arrangement—the intestine turning posteriorly after leaving the stomach, and not anteriorly as in *Ascidia*—but they are relatively larger, and extend further anteriorly than in *Corella parallelogramma*. They occupy chiefly the ventral part of the right side, and extend beyond the branchial sac, the intestine appearing at the posterior end and ventral edge of the sac when viewed from the left side (Pl. XXVI. fig. 2, *i.*). In consequence of an anterior twist in the œsophagus, the stomach lies nearly antero-posteriorly (Pl. XXVI. fig. 3), and the intestine before turning towards the posterior end, reaches almost to a level with the atrial aperture.

The genitalia branching over the intestine in its anterior part, and occupying the loop, are, relatively to the alimentary canal, and relatively to the genital mass in *Corella parallelogramma*, and in *Abyssascidia*, small and inconspicuous. The vas deferens is conspicuous, running between the stomach and the posterior part of the intestine, and then between the œsophagus and the rectum towards the atrial aperture (shown as a dark line in Pl. XXVI. fig. 3).

Nearly a dozen specimens of this species, all of much the same size, were obtained off Kobé, Japan, at Station 233A; May 17 to 19, 1875; lat. 34° 35′ N., long. 135° 10′ E.; depth, 8 to 50 fathoms. Two specimens were also dredged in shallow water off Yokohama, Japan; and two at Hong Kong, in 10 fathoms.

Abyssascidia, Herdman.

Abyssascidia, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 470.

Body oblong, attached by ventral surface. Branchial aperture with about twelve lobes, atrial with about eight lobes.

Test cartilaginous, soft and transparent.

Mantle thin. A few large distant muscle bands on left side.

Branchial Sac not longitudinally plicated; stigmata straight.

Dorsal Lamina replaced by languets.

Tentacles simple, filiform.

Viscera on right side of branchial sac. Intestine small. Stomach short and wide.

Genitalia forming a round mass situated on the right side of the intestinal loop.

The genus *Abyssascidia* occupies a position intermediate between *Ascidia* and *Corella*, with both of which it has affinities. It resembles the latter genus in the position of the viscera, and in the shape and relative size of the intestine. The most striking peculiarities of the genus are the number of lobes around the apertures and the position and form of the alimentary canal.

The branchial sac, however, differs greatly from that of *Corella*, and exhibits the simpler structure found in *Ascidia*, while the membranes hanging from the transverse vessels and the languets along the dorsal edge of the branchial sac are exactly like the same parts in *Corella*.

The genus was formed for the reception of a single species from deep water, *Abyssascidia wyvillii.*

Abyssascidia wyvillii, Herdman (Pl. XXVII.).

Abyssascidia wyvillii, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 470.

External Appearance.—The body is irregularly oblong in shape, rather pointed at the anterior, and rounded at the posterior, end. It is attached to a small manganese nodule by the lower (ventral) surface in front of the middle. The lateral edges are rudely parallel. The body is flattened dorso-ventrally, so that the branchial aperture being anterior, the atrial is on the upper surface, three-quarters of the way to the posterior end, and rather to the right of the middle. In consequence of this, more of the left than of the right side enters into the formation of the upper surface. The branchial aperture is at the edge, slightly to the right of the anterior end, and has twelve or fourteen lobes; the atrial has eight or nine lobes, both apertures are sessile.

The surface is smooth. The colour is a very light grey, almost transparent.

Length of the body, 6 cm.; breadth of the body, 4 cm.

The Test is thick; it is rather solid, but not hard, and is transparent. No vessels are visible. The test contains only small fusiform cells in the hyaline matrix; there are no bladder cells.

The Mantle is very thin, the endostyle and viscera being seen distinctly through it. A few large distant muscle bands run round the right edge, and extend over the left side nearly as far as the endostyle. The atrial siphon is prominent, and provided with fine muscle bands; the branchial is also muscular, but not projecting.

The Branchial Sac is large, and fills the whole mantle cavity; it is not plicated, and its structure is simple. Every alternate transverse vessel is slightly wider than the intermediate ones, and here and there the stigmata extend from one larger vessel to the next, cutting through the intermediate smaller one. The internal longitudinal bars widen slightly at each intersection with a transverse vessel, but bear no papillæ. Tusk-shaped ducts, to which horizontal membranes are attached, connect the transverse vessels with the swellings on the internal longitudinal bars. The stigmata are rather wide and irregular; there are about three in a mesh, which is generally nearly square.

The Dorsal Lamina is reduced to a series of conical languets, which are blunt, comparatively short, and irregular in size.

The Tentacles are few, distant, small, and filiform; there are two at each side of the anterior end of the endostyle, and a few others in the usual circle, but separated by nearly their own length from each other.

The Dorsal Tubercle is carrot-shaped, tapers posteriorly, and has no visible aperture.

The Nerve Ganglion is elongated. It is placed at a considerable distance from the dorsal tubercle.

The Alimentary Canal is placed on the right side of the branchial sac, at the posterior end, and is relatively small.

The Genitalia form a rounded mass of large size, which lies on the right side of the intestinal loop at the ventral end.

This interesting form belongs undoubtedly to the Ascidiidæ, notwithstanding the large number of lobes around the apertures. These lobes are mostly well defined, but a few are rather indistinct, consequently the numbers might be considered for the branchial aperture as either twelve, thirteen or fourteen, and for the atrial as either eight or nine (Pl. XXVII. fig. 1). The position of the atrial aperture, rather to the right of the middle of the upper surface, is curious; and the area of attachment being nearer the anterior than the posterior end is also a peculiarity (Pl. XXVII. fig. 2). The body is depressed, or flattened dorso-ventrally in place of laterally, and as a consequence the edges are formed by the right and left sides, and not by the dorsal and ventral lines. The test is thick and cartilaginous, but soft and very clear; no vessels nor bladder cells were observed. When the test is removed the body is seen to be very much smaller[1] than the cavity in which it lies (Pl. XXVII. figs. 3 and 4, and compare with figs. 1 and 2). It is relatively narrower than when covered by the test, and has the posterior end wide on account of the large postero-dorsal process, at the extremity of which the atrial aperture opens (Pl. XXVII. fig. 3, *at.*).

The mantle is very thin, and the muscle bands on its left side and dorsal edge (Pl. XXVII. figs. 3 and 4, *m.b.*) are very strong, and bear a considerable resemblance to the musculature in the genus *Corella*. The muscle bands on the siphons are fine, and are more numerous on the atrial than on the branchial. They do not form distinct sphincters.

The branchial sac is of the simplest possible type, having no folds and not being longitudinally plicated, the stigmata being straight, and the internal longitudinal bars bearing no papillæ (Pl. XXVII. fig. 7). The connecting ducts between the transverse vessels and the internal longitudinal bars are long and curved (Pl. XXVII. fig. 9, *c.d.*), and support between them the delicate horizontal membranes which hang round the interior of the sac (fig. 7, *h.m.*).

The languets are short and blunt somewhat finger-shaped processes, placed close together along the dorsal line, and not all of the same length (Pl. XXVII. fig. 11, *l.*).

The endostyle is normal. The tentacles are very slight, and have a curious arrangement. The two pairs placed at the ventral end of the circle, and the two neighbouring isolated tentacles, are shown in figure 12 on Plate XXVII., and two others from the lateral part of the circle are shown in figure 13. The long tapering dorsal tubercle (Pl. XXVII. fig. 14, *d.t.*) lies about three times its own length in front of the elongated

[1] The specimen had been in spirit for about six years when examined.

nerve ganglion (fig. 15), which thus comes to be placed at a considerable distance from the branchial aperture.

The course of the alimentary canal (Pl. XXVII. figs. 3, 5 and 6) is very similar to that found in *Corella parallelogramma*. The narrow œsophagus (Pl. XXVII. fig. 6, *œ.a.*) opens near the base of the branchial sac at the dorsal edge, and runs horizontally (the branchial aperture being superior) for a short distance, and then opens into the barrel-shaped stomach (figs. 5 and 6, *st.*), which has its wall raised externally into about twelve rounded longitudinal ridges, and is situated about half-way across to the ventral edge. From the opposite end of this stomach the intestine curves ventrally and slightly upwards, then downwards, and then runs parallel to its first part (Pl. XXVII. figs. 3, 5 and 6, *i.*), past the stomach and œsophagus, turns upwards, runs past the œsophageal opening, and ends in a prominent anus (figs. 5 and 6, *a.*) not far from the posteriorly placed atrial aperture. The fæces are brown.

The genital mass is situated, as is usual in the genus *Corella*, upon the ventral portion of the intestine, where it turns round posteriorly after leaving the stomach.

The ovary (Pl. XXVII. fig. 16, *ov.*) forms the central part of the genital mass, and the testis occupies the periphery, and consists of pyriform spermatic vesicles (Pl. XXVII. figs. 16 and 18, *t.v.*) full of small spherical cells.

The oviduct and vas deferens emerge from the dorsal and posterior end of the mass, and course along the superior (anterior) margin of the intestine (Pl. XXVII. fig. 5, *g.d.*) to their termination.

One specimen of *Abyssascidia wyvillii* was obtained to the south of Australia, at Station 160; March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; depth, 2600 fathoms; bottom temperature, 0°·2 C.; bottom, red clay.

Ascidia, Linnæus.

Ascidia, Linnæus, Syst. Nat., 12th Edn. 1766. In part.
Ascidia, O. F. Müller, Zoologia Danica. 1780. In part.
Ascidia, Cuvier, Mém. sur les Ascidies, Mém. du Mus., vol. ii. 1815. In part.
Phallusia, Savigny, Mém. sur les Anim. sans Vertèbres, pt. ii. fasc. 1. 1816. In part.
Ascidia, Forbes and Hanley, Brit. Moll., vol. i. 1853. In part.
Ascidia, Alder, Observations on Brit. Tunicata, Ann. and Mag. Nat. Hist., ser. iii., vol. xi. 1863. In part.
Ascidia, Hancock, On the larval state of *Molgula*, &c., Ann. Mag. Nat. Hist. ser. iv., vol. vi. 1870.
Ascidia and *Ascidiopsis*, Verrill, Amer. Journ. of Science and Arts, ser. iii., vol. i. 1871.
Ascidia, Heller, Untersuchungen ü. d. Tunicata adriat. Meeres., Abth. 1. 1874.
Phallusia, Kupffer, Jahresber. der Commiss., &c. 1875.
Phallusia, Traustedt, Oversigt over de fra Danmark, &c., Asc. Simp. 1880.
Ascidia and *Phallusia*, Julin, Recher. sur l'organ. des Asc. Simp.—Sur l'Hypophyse, &c. 1881.

Body attached, sessile, usually oblong or ovate in shape. Branchial aperture eight-lobed, atrial six-lobed.

Test cartilaginous, but soft and flexible, sometimes thin and membranous; rarely prolonged into hair-like processes, or covered with sand.

Branchial Sac never folded, sometimes minutely plicated. Internal longitudinal bars present, and usually papillated; stigmata straight.

Dorsal Lamina in the form of a plain, or more or less ribbed and pectinated membrane.

Tentacles simple.

Viscera placed upon the left side of the branchial sac.

Genitalia in the intestinal loop.

Whether the present genus should be called *Ascidia* or *Phallusia* is now a matter of individual opinion, and it makes little difference which name is finally adopted. *Ascidia* seems preferable for two reasons:—(1), it was the name first given, although in a wider sense than as at present used; (2), it has been more generally employed than *Phallusia.*

Baster, in 1762 (Opuscula subseciva, vol. i.), gave the name *Ascidium* to a species of Simple Ascidian. This was afterwards changed by Linnæus to *Ascidia*, and under that name all the Simple Ascidians are grouped in the 12th edition of the "Systema Naturæ," and in O. F. Müller's "Zoologia Danica."

Savigny, in 1816, divided Linnæus's *Ascidia* into the four genera—*Phallusia, Cynthia, Boltenia* and *Clavelina.* Of these *Phallusia* most nearly corresponds with the present genus, but had wider limits, including the entire family Ascidiidæ. Since Savigny's time *Ascidia* has been used by some authors and *Phallusia* by others.

The main objection to using *Ascidia* is, that when first proposed it included more than what we now include in the genus, but this same objection holds in regard to *Phallusia* also; as used by Savigny, the latter term comprised *Ciona* and *Corella*, and was exactly equivalent to *Ascidia* as used by Forbes in his "British Mollusca" (1853). In precisely the same sense, *Ascidia* has been used since by Alder in 1863, and by Claus in 1876, and *Phallusia* by van der Hoeven in 1856, and by Kupffer in 1870.

Hancock (1870) employed *Ascidia* in the restricted sense in which it is used here, and has been used by Heller and others; while *Phallusia* in the same restricted sense (*i.e.*, not including *Ciona* and *Corella*) has been employed by Kupffer in his "Jahresber. der Commiss., &c.," 1875, and by Traustedt in 1880.

Hence it appears that whether we take the name first applied without regarding the limits of the genus, or merely the name that was first used in the present restricted sense, we find that *Ascidia* has the priority over, and has been rather more generally accepted than, *Phallusia.*

Ascidia is the largest and best known genus of the Ascidiidæ, and may be considered as the typical form. In shape it is usually irregularly ovate or elongated antero-posteriorly, and it is attached by the posterior end or part of the left side of the body. It is very rarely [1] covered with incrusting sand and other foreign bodies. Usually the branchial aperture is surrounded by eight lobes and the atrial by six, but the former may have seven or nine, and the latter five or seven.

The test is usually thick, but soft and flexible, and more or less transparent. In a typical species (*e.g.*, *Ascidia mentula*, O. F. Müller) it is plentifully supplied with blood-vessels, and the terminal knobs in the outer layers are surrounded by quantities of large ovate bladder cells (fig. 18, *a*).

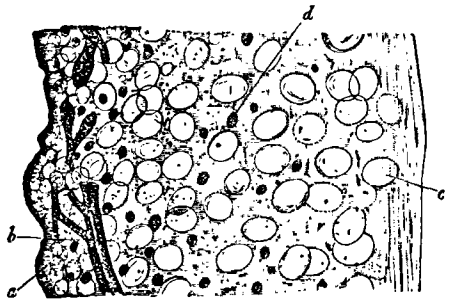


FIG. 18.—Transverse section through the test of *Ascidia*, showing the matrix in which lie large bladder cells (*c*) scattered in the inner layers, and smaller bladder cells (*a*) near the surface (the left side of the figure), blood-vessels (*b*) with terminal knobs, and pigment cells (*d*)—magnified about 40 times.

In some species (*e.g.*, *Ascidia nigra*, Savigny) many of the cells become pigmented, thus colouring the whole test and rendering it opaque. In a few cases the test is very thin and membranous, and appears to have no vessels.

The mantle is never very thick. It is usually fairly muscular on the right side where it lies over the branchial sac, but the muscle bands are not arranged according to a definite system, as they are in many of the Cynthiidæ. There are a number of bundles which radiate from the bases of the siphons, and some others which cross the anterior and dorsal region lying between the branchial and atrial apertures. These usually form longitudinally running sets of bundles, which, however, branch and anastomose so as to make an irregular network. They are crossed at right angles, and obliquely, by a series of more or less transversely running bands, which terminate at the dorsal and ventral edges, or very slightly beyond them, as the left side of the body over the viscera is almost or entirely destitute of muscular fibres. The siphons are very rarely prominent,[2] and the sphincters are usually only of moderate strength.

[1] *Ascidia involuta*, Heller, is one of the exceptions.

[2] *Ascidia longitubis*, Traustedt, has both siphons enormously elongated, and *Ascidia pyriformis*, Herdman (Pl. xxxiv. fig. 3), shows the same condition in a less marked degree.

The branchial sac has never large longitudinally running folds, such as are found in the Molgulidæ and Cynthiidæ. The system of internal longitudinal bars is always present, and is well developed. These tubes, by their intersection with the transverse vessels, form the meshes visible on the inner surface of the sac (fig. 19), and at the

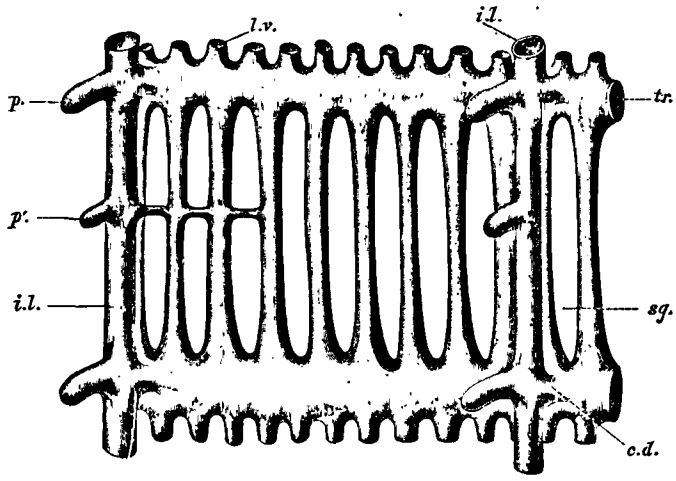


FIG. 19.—A Single Mesh of the Branchial Sac of *Ascidia*, seen from the inside.

tr., transverse vessel; *i.l.*, internal longitudinal bar; *l.v.*, fine longitudinal vessel; *p.*, papilla; *p'.*, smaller intermediate papilla; *c.d.*, connecting duct; *sg.*, stigma.

corners of the meshes the internal longitudinal bars bear usually knob-like projections or papillæ (fig. 19, *p.*) projecting into the interior of the sac. In some species (*e.g.*, *Ascidia aspersa*, O. F. Müller, and *Ascidia styeloides*, Traustedt), these papillæ are absent, or very rudimentary; while in other species (*e.g.*, *Ascidia meridionalis*, Herdman, and *Ascidia*

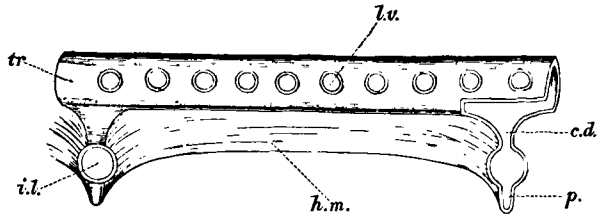


FIG. 20.—Diagrammatic horizontal section through a Mesh of the Branchial Sac of *Ascidia*, showing the interior of the transverse vessel, connecting duct, and papilla at the right hand end.

tr., transverse vessel; *l.v.*, fine longitudinal vessel; *i.l.*, internal longitudinal bar; *p.*, papilla; *c.d.*, connecting duct; *h.m.*, horizontal membrane.

depressa, Alder), a series of smaller intermediate and alternating papillæ is present on the internal longitudinal bars in addition to those at the angles of the meshes.

In the simplest condition the transverse vessels are all of one size, and the interstigmatic vessels connecting them are placed in one plane, forming a continuous row (fig. 20); but in many species (*e.g., Ascidia meridionalis*) there are two or more distinct sizes of transverse vessels, which are usually placed so as to alternate regularly; and in some species the fine longitudinal or interstigmatic vessels are arranged so that their line of insertion into the transverse vessels forms an undulating in place of a straight line (fig. 21), or is even more irregular (Pl. XXIX. fig. 4).

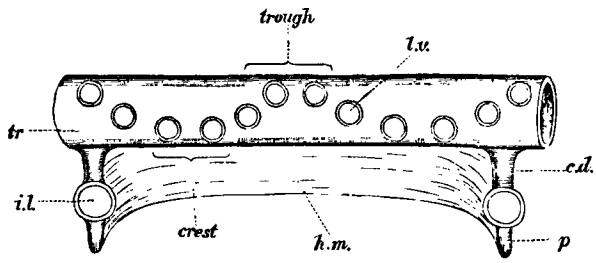


FIG. 21.—Diagrammatic horizontal section through a Mesh of the Branchial Sac of *Ascidia,* showing the arrangement of the fine longitudinal vessels which causes "minute plication."

tr., transverse vessel; *l.v.*, fine longitudinal vessel; *i.l.*, internal longitudinal bar; *c.d.*, connecting duct; *p.*, papilla; *h.m.*, horizontal membrane. "Crest" indicates the highest, and "trough" the lowest part of the undulation.

The result of this arrangement is that the sac, when seen from the inside, or still better from the outside (Pl. XXXI. fig. 5, and Pl. XXXIII. fig. 3), where there are no internal longitudinal bars to obscure the view, seems to be thrown into a series of minute crimps or plaits, and this is the structure which has been called "minute plication."

Verrill,[1] in 1872, suggested that *Ascidia complanata,* Fabricius, should form the type of a new genus, to which he gave the name *Ascidiopsis,* on account of the remarkable structure of its branchial sac; but from the figure given, this structure seems to be merely the above described minute plication which is found in *Ascidia mentula, Ascidia virginea,* and a number of the oldest known and most typical species of the genus *Ascidia.* The plication varies considerably in the degree to which it is present, and also in its regularity. Usually when the sac is plicated there are several sizes of transverse vessels, and the smaller sizes may enter into the undulations of the stigmatic vessels, while the larger ones do not. In this case the appearance of the outer surface of the sac, when the plication is regular, is that of a number of alternately placed projections and

[1] Descriptions of some imperfectly known and new Ascidians from New England, Amer. Journ. Sc. and Arts, ser. iii., vol. iii., No. 16.

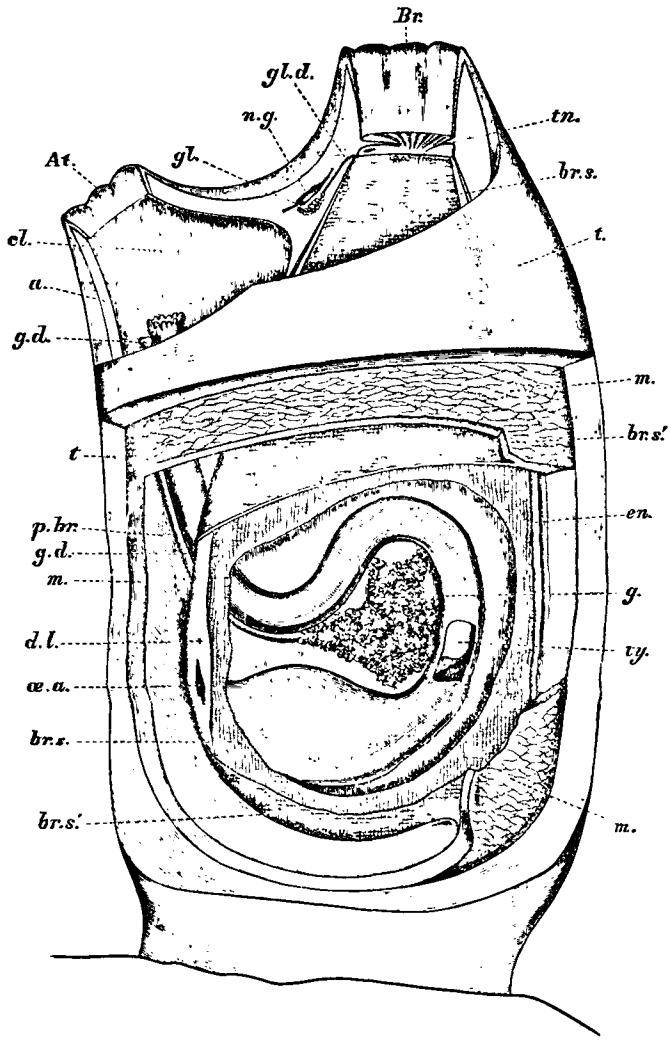


FIG. 22.—Diagram of a dissection of *Ascidia*, from the right side, to show the relations of the different "tunics" and cavities, the course of the alimentary canal, &c.

Br., branchial aperture; *At.*, atrial aperture; *t.*, test; *m.*, mantle; *br.s.*, branchial sac; *br.s'.*, outer surface of branchial sac; *en.*, endostyle; *d.l.*, dorsal lamina; *p.br.*, peribranchial cavity; *tn.*, tentacle; *cl.*, cloaca; *œ.a.*, œsophageal aperture; *ty.*, typhlosole in intestine; *a.*, anus; *n.g.*, nerve ganglion; *gl.*, neural gland; *gl.d.*, duct from neural gland; *g.*, genital organs; *g.d.*, genital duct.

depressions arranged antero-posteriorly between the larger transverse vessels, but not joining across them (Pl. XXXIII. fig. 3). In this way a series of shallow pouches is formed, opening off the peribranchial cavity.

The dorsal lamina varies in its character, from a plain broad membrane with a smooth edge and no markings, to a closely ribbed structure, with the free edge provided with one or more series of large pointed knob or tooth-like processes, the larger of which usually correspond to the ends of the ribs, and are in the same line with the transverse vessels of the sac.

The tentacles are usually large, and very frequently of several sizes, arranged symmetrically (Pl. XXXIII. fig. 5). Each tentacle is long, tapering and filiform; it is triangular in cross section, and is placed so that one of the sides is anterior and the opposite angle posterior.

The dorsal tubercle is as a rule comparatively simple. The typical form in the genus has a horse-shoe shape, with the aperture placed anteriorly, and the horns turned slightly either inwards or outwards, but not coiled spirally, as in most of the Molgulidæ and Cynthiidæ.

The stomach and intestine lie upon the left side of the branchial sac, and the usual arrangement is that shown in fig. 22, p. 201, where the ventrally directed œsophagus leads into a globular stomach, which reaches to the ventral edge of the body. The intestine, after emerging from the stomach, runs anteriorly, then dorsally, and then posteriorly to form a loop (the intestinal loop) which is open posteriorly. It then turns dorsally and anteriorly again, becoming the rectum which runs forwards near the dorsal edge of the left side, and completes a second loop (the rectal loop), which is open anteriorly.

The branched ovary and testis occupy the intestinal loop (fig. 22, *g.*), and extend over the adjoining parts of the stomach and intestine, while their ducts run along the posterior and dorsal edge of the intestine and rectum, to open into the peribranchial cavity anteriorly near the anus.

A renal organ is present in the form of a mass of clear thin-walled and large vesicles, usually containing concentrically laminated yellow and brown concretions. It occupies the rectal loop and the adjoining regions of the left side of the body.

Eleven species of *Ascidia* were collected during the Challenger expedition, and they were all new to science, with the exception of the apparently common West Indian species, *Ascidia nigra*, Savigny.

Ascidia challengeri, n. sp. (Pl. XXX.).

External Appearance.—The shape of this species is irregularly oblong, with the anterior end rather narrow; the posterior, which forms the base of attachment, is slightly broader, and the dorsal and ventral edges diverge slightly as they run backwards, and are sometimes curved. The branchial aperture is anterior, terminal, or slightly on the

right side; it is prominent, and distinctly lobed. It is directed anteriorly and to the right side. The atrial aperture is on the dorsal edge, one-fourth to one-third of the distance from the anterior to the posterior end. It is prominent, is distinctly lobed, and points more or less anteriorly.

The surface is rather uneven, being seamed by a number of shallow grooves, which have mostly a longitudinal course. The posterior end of the body, which is usually prolonged into a more or less uneven base of attachment, has often irregular rough processes projecting from it. The colour is a dull yellowish-grey, with occasional darker patches, especially at the place of attachment.

Length of the body, 17 cm.; breadth of the body, 5·5 cm.

The Test is cartilaginous and moderately thick, but soft and flexible. Vessels are abundant.

The Mantle is strong, and the musculature is well developed on the right side of the body and round the apertures.

The Branchial Sac is strong, and is slightly plicated longitudinally. The transverse vessels are of two sizes, but these are not arranged with great regularity; usually several of the smaller size occur between every two of the larger. The internal longitudinal bars are strong and regular, and bear large curved papillæ at the points of intersection with the transverse vessels and smaller intermediate ones, which are usually connected by delicate horizontal membranes. The meshes are slightly elongated transversely, and contain each eight to ten stigmata. Occasionally much narrower transverse vessels are present for short distances, thus forming two rows of small stigmata in a mesh.

The Dorsal Lamina is a broad membrane, strongly ribbed transversely, and having the edge toothed in some parts and plain in others.

The Tentacles are simple, not long but rather stout, and all of one size.

The Dorsal Tubercle is large but simple. It lies in a shallow peritubercular area, and extends anteriorly almost to the bases of the tentacles. The shape of the tubercle is ovate, while the aperture is at the narrower anterior end. Both horns are turned to the right.

This is a large and somewhat variable species, which appears to be common at Kerguelen Island. In the first part of the Preliminary Report it was considered as being identical with *Ascidia mentula*, O. F. Müller, a species to which it is closely allied.

The body is elongated, and in the larger specimens is often curved (Pl. XXX. fig. 1), while in younger examples it has a much more regular form, and is not so elongated (Pl. XXX. fig. 2). In the young individual also the area of attachment at the posterior end is comparatively small, while in the larger specimens it is much produced and irregularly twisted, extending in one case more than 7 cm. beyond the posterior end of the body.

The following list gives the chief dimensions of twelve specimens of this species :—

	Length (antero-posterior).	Breadth (dorso-ventral).	Length of the posterior prolongation for attachment.
1.	14·5 cm.	6 cm.	3·5 cm.
2.	13 cm.	6 cm.	7 cm.
3.	13 cm.	6 cm.	3 cm.
4.	12 cm.	6 cm.	2·5 cm.
5.	12 cm.	5 cm.	— [1]
6.	11 cm.	5·5 cm.	8 cm.
7.	6 cm.	3·5 cm.	2·5 cm.
8.	6 cm.	3·5 cm.	— [2]
9.	5 cm.	2·4 cm.	None.
10.	5 cm.	2 cm.	None.
11.	4·8 cm.	2·8 cm.	None.
12.	4·5 cm.	2·5 cm.	None.

The apertures are conspicuous and distinctly lobed (Pl. XXX. figs. 1 and 2). The atrial aperture is not distant from the branchial and is always more prominent.

The test is that of a typical *Ascidia*, and contains numbers of large oval or spherical bladder-cells, especially in the outer layers (Pl. XXX. fig. 3, *bl.*). Vessels are abundant and branch freely, but their terminal knobs (Pl. XXX. fig. 3, *t.k.*) are rather small.

The branchial sac is very like that of *Ascidia mentula*. It has the same irregularity in the disposition of the stigmata, as seen from the inside, caused by a slight longitudinal plication. The internal longitudinal bars are strong, and with their prominent curved papillæ form a conspicuous feature in the internal view of the sac (Pl. XXX. fig. 4). Delicate horizontal membranes are present along the inner edges of the transverse vessels, extending between the papillæ, and also frequently in intermediate positions connecting the small papillæ.

The dorsal lamina, as may be seen from a glance at figures 5, 6 and 7 on Plate XXX., varies considerably in its characters. Figure 6 shows what seems an unusual condition, where the edge is crenated, and bears a number of small irregularly placed pointed processes. The most prominent of these are always placed opposite the terminations of the ribs. Figure 7 represents the right side of the lamina, near the base.

The dorsal tubercle (Pl. XXX. fig. 8, *d.t.*) is very large, and in the specimen figured was not nearly contained within the shallow peritubercular area. In another individual which was examined, the peritubercular area was much deeper and more cup-shaped. It enclosed almost the whole of the tubercle. The anterior peripharyngeal band, which is in close relation to the posterior end of the dorsal tubercle, lies at a considerable distance from the dorsal ends of the right and left posterior bands, which turn posteriorly and converge towards the anterior extremity of the dorsal lamina (Pl. XXX. fig. 8, *p.p.*). The tentacles are comparatively short but stout.

[1] This specimen was attached by the left side of the body, and has no posterior prolongation.
[2] The posterior prolongation was torn in this specimen.

The viscera are large; the intestinal loop is narrow, and extends for a considerable distance anteriorly.

Specimens of this species were obtained at three localities off Kerguelen Island, Station 149, namely, Balfour Bay, January 19, 1874, 20 to 60 fathoms, 5 specimens; Royal Sound, January 20, 1874, 28 fathoms, 6 specimens; and Kerguelen, 10 to 60 fathoms, 2 specimens.

Ascidia vasculosa, Herdman.

Ascidia vasculosa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879-80, p. 465.

External Appearance.—The shape is very irregular, and is somewhat quadrangular and depressed. The anterior end is a little prolonged and narrower than the rest, and the body is attached by the left side near the base. The branchial aperture is not quite terminal, being on the right side of the anterior extremity. The atrial aperture is also on the right side, nearer the dorsal than the ventral edge, and a little in front of the middle. Both the apertures are rather depressed and concealed.

The surface is very irregular, it is grooved and mammillated, and has Compound Ascidians, Annelid-tubes, &c., adhering to it. It is of a light yellowish-grey colour, is not opaque, being rather hyaline at the edges, and showing everywhere numerous blood-vessels ramifying near the surface. The terminal twigs of the vessels, with their swollen ends, are a prominent feature.

Length of the body, 9 cm.; breadth of the body, 5·6 cm.

The Test is cartilaginous and solid, and varies in thickness from less than 0·5 mm. on the right side behind the middle to 1·5 cm. on the left side near the place of attachment. The apertures are lobed indistinctly; the vascular trunks enter on the left side near the ventral edge, and branch usually dichotomously, the terminal twigs ending in swollen knobs. The test shows no bladder cells. It contains the usual small spherical fusiform and stellate cells, and many minute granules. Crystals or concretions are also present, generally in the form of short rods and crosses.

This is a specimen from the collection made at Kerguelen Island, of which nothing remains but the test. This organ seemed to me, however, to be so distinct from that of the other known species of *Ascidia*, that I described it in the first part of the Preliminary Report under the name of *Ascidia vasculosa*.

The shape is very irregular, having various grooves and projections, and being covered with several adhering animals. The blood-vessels are the distinctive feature. They are numerous and of large size, and show very distinctly from the outer surface of the test. Probably the crystals mentioned in the above description are a post-mortem change, possibly the result of the long immersion in spirit.

One specimen (the test only) was found at Station 149, Royal Sound, Kerguelen Island, January 20, 1874; depth, 28 fathoms.

Ascidia placenta, Herdman (Pl. XXXI. figs. 1–3).

Ascidia placenta, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 715.

External Appearance.—The body is elongated, oblong, elliptical or oval in shape, and is flattened laterally; the anterior end is slightly the narrower, and the posterior end is rounded. It is attached by a small area a little posterior to the middle of the left side. The apertures are both on the right side; they are sessile, and not conspicuous. The branchial is nearly median and terminal; the atrial is a short distance from the dorsal edge, nearly half-way down from the anterior to the posterior end.

The surface is rather creased by seams running for the most part longitudinally, and is slightly roughish or velvety.

The colour is a yellowish-grey or horn colour.

Length of the body, 6·5 cm.; breadth of the body, 4 cm.

The Test is rather thin, soft, and easily torn. It is roughish about the base of attachment. The inner surface is smooth and glistening. Vessels are feebly developed.

The Mantle is moderately muscular.

The Branchial Sac is delicate, and is slightly plicated longitudinally. The transverse vessels are all of one size. The internal longitudinal bars are moderately strong, and bear at the angles of the meshes very long curved papillæ, connected by delicate transverse membranes. The stigmata are long and narrow, and are usually wider than the interstigmatic vessels; there are eight to twelve in a mesh. The meshes are large and rather longer transversely than antero-posteriorly.

The Dorsal Lamina is not ribbed, or only slightly so in places. Every here and there a large tooth in the form of a short finger-like process is present, and between these are usually three or four smaller ones.

The Tentacles are filiform, about twenty-four in number, and all of one length.

The Dorsal Tubercle is longish elliptical in shape, and is placed antero-posteriorly, with the opening at the anterior end.

This species is much compressed laterally, and as its point of attachment is near the centre of the left side, it must have lived in a more or less horizontal position, as an expanded flattened cake-like structure (Pl. XXXI. fig. 1). In external appearance it resembles *Ascidia tenera* somewhat, but they differ greatly in details of structure.

The branchial sac is very delicate (Pl. XXXI. fig. 2), and the stigmata are long and in some places rather irregular. The papillæ are very large, and are found bent in all directions. The smaller intermediate ones which are occasionally present may be connected by delicate transverse vessels, much slighter than the usual ones.

The dorsal lamina is usually devoid of transverse ribs, as represented in figure 3, but in some parts of its extent very slight ribs are present, running towards the larger marginal teeth.

Two specimens were obtained to the south of Kerguelen Island, at Station 150; February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bottom temperature, 1°·8 C.; bottom, rock.

Ascidia meridionalis, Herdman (Pl. XXXI. figs. 4–8).

Ascidia meridionalis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 465.

External Appearance.—The shape is somewhat variable; it is generally oval, the anterior end being rather narrower than the posterior. The posterior end is rounded, and the anterior more or less pointed. The body is flattened laterally, and is attached by the posterior end and part of the left side. The branchial aperture is terminal, at the extremity of a large conical process, the apex of which is inclined ventrally and to the right; the atrial aperture is to the right of, or on the dorsal edge, about one-third of the way down; it also is on a process, which, however, does not usually project so much as the branchial one; it is directed dorsally, anteriorly, and slightly to the right; the lobes of both apertures are distinct.

The surface is slightly velvety; otherwise it is smooth, but more or less creased and seamed. The colour is light brown or horn colour.

Length of the body, about 12 cm.; breadth of the body, about 8 cm.

The Test is softish, and tears easily, it is from 1·5 to 6 millimetres thick, the left side being thicker than the right. Vascular trunks enter about the middle of the left side, near the ventral margin, and large vessels are seen ramifying on the inner surface, which is smooth and shining.

The Mantle is moderately muscular.

The Branchial Sac is slightly plicated longitudinally. Three small transverse vessels occur between each pair of large ones. The internal longitudinal bars are strong, and bear short stout papillæ at the angles of the meshes, and also small conical intermediate ones. The meshes are slightly longer transversely than antero-posteriorly, and contain each 6 to 8 stigmata. The stigmata are elongate-elliptical in shape.

The Dorsal Lamina is broad, and is ribbed transversely; the margin is serrated.

The Tentacles are simple, filiform, about sixty in number, and placed long and short alternately.

The Dorsal Tubercle is crescentic in shape, with the horns pointing anteriorly.

This is a large and well marked species; the form is more or less oval, the anterior end being the narrower (Pl. XXXI. fig. 4). In some of the specimens, however, the shape is a good deal more irregular than in the one figured. The apertures are placed on large conical projections, the sides of which are channelled by the grooves leading down from between the lobes. In one specimen the branchial aperture is only seven-lobed, while

in another it is distinctly nine-lobed. A few Sponges, Polyzoa, &c., are attached in some of the specimens to the left side.

The following list shows the dimensions in twelve individuals of this species :—

	Length of Body.	Breadth of Body.		Length of Body.	Breadth of Body.
1.	14 cm.	8 cm.	7.	11·5 cm.	7 cm.
2.	12·5 cm.	8·5 cm.	8.	11 cm.	7 cm.
3.	12 cm.[1]	13 cm.	9.	11 cm.	6·5 cm.
4.	12·5 cm.	8 cm.	10.	8 cm.	4·5 cm.
5.	12 cm.	7 cm.	11.	7·5 cm.	5·5 cm.
6.	12 cm.	6·5 cm.	12.	5·5 cm.	3·5 cm.

The test is moderately thick but very soft. The blood-vessels are large and abundant, and are conspicuous on the inner surface of the left side. Their terminal twigs in the outer layers have enlarged knob-like ends. Bladder cells are abundant; they are very large throughout the inner three-fourths of the thickness, but in the outer fourth they become smaller and are more closely packed. The ordinary minute fusiform cells are also present. The mantle is of moderate strength; the musculature is irregular on the right side of the body and the anterior half of the left, while it is absent on the posterior half of the left, over the stomach and intestine.

The branchial sac (Pl. XXXI. figs. 5 and 6) is large, completely filling the mantle cavity. It is slightly plicated longitudinally, and the stigmata are arranged in alternate bands of narrower and wider ones corresponding with the crests and troughs of the plications. The large transverse vessels are very wide, and are somewhat encroached upon by the ends of the narrower stigmata. In figure 5, which shows the outer (atrial) side of the branchial sac, one of the muscular suspensors or tubes (*s.*) connecting the sac with the mantle is seen at the right hand lower corner.

The dorsal lamina (Pl. XXXI. fig. 7) is broad but delicate, and the edge is strongly serrated; it extends a little more than two-thirds of the way down to where the œsophageal opening is placed. The tentacles (fig. 8, *tn.*) are filiform, and the longer ones are very long and thin, running out to fine terminations.

The nerve ganglion is oblong, of a yellow colour, and gives off two large nerves at each end—one pair to the branchial and the other to the atrial aperture.

The alimentary, genital, and renal viscera form a large but flat mass upon the posterior half of the left side. The œsophageal aperture is situated near the posterior end of the sac, and from it the œsophagus runs posteriorly and ventrally; the large stomach continues the curve, running ventrally and anteriorly, and then turns directly anteriorly; the intestine, after leaving the stomach, continues anteriorly, then bends dorsally for a short distance, and then runs back again posteriorly, nearly parallel to the stomach; finally it bends forwards, and runs anteriorly and dorsally to end in a wide anus, a little

[1] This specimen was not perfect, it must have been of enormous size.

way inside the atrial aperture. In almost its entire course the alimentary canal is concealed by the genital and renal glands. A system of fine tubules, branching dichotomously, slightly swollen at the points of division, and ending in elongated enlargements, is present upon the wall of part of the stomach and intestine. The heart lies along the ventral edge of the stomach. The fæces in the rectum are of a dark greenish-brown colour.

The ovary ramifies over the anterior part of the intestine and in the narrow intestinal loop, and the oviduct is seen distinctly running from the groove between the stomach and intestine, along the lower edge of the latter, to end near the anus, beyond which it projects slightly. The testis is composed of numerous small oval or pyriform vesicles of a pale yellow colour, connected with the terminal twigs of a duct which branches dichotomously over the intestine. The vas deferens runs alongside the oviduct as a conspicuous pale yellow tube. The oviduct is very delicate, and lies behind the vas deferens, partly encircling it.

The renal gland is of great extent, covering almost the entire stomach and intestine. It consists of a number of vesicles of large size, having in mass a pale brown colour. Each vesicle is in its outer part perfectly transparent, but it encloses in its centre one or more rather brilliant yellowish-brown concretions, which are soluble in hydrochloric acid, and have a concentrically laminated structure, and often a dark brown centre. Besides these brown concretions, there are also usually present in each vesicle several clear rosette-shaped bunches of crystals, which may possibly not be urinary deposits, but may have been formed by post-mortem changes. The vesicles are quite isolated, and communicate with no duct.

There are also to be seen scattered through the renal mass a number of small spherical opaque white bodies, apparently lying quite freely in the surrounding tissues. These dissolve with effervescence in hydrochloric acid, revealing a brown centre similar to the concretions mentioned above. This centre also rapidly dissolves, leaving a dark brown nucleus, which very slowly dissolves, breaking up into a brown débris which remains undissolved. These white bodies are probably the ultimate form of the brown concretions seen in the vesicles.

Several specimens of this species were obtained off the coast of Buenos Ayres, South America, at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground; and two specimens in the Straits of Magellan, at Station 313; January 20, 1876; lat. 52° 20′ S., long. 68° 0′ W.; depth, 55 fathoms; bottom temperature, 8°·8 C.; bottom, sand.

Ascidia nigra, Savigny.

Phallusia nigra, Savigny, Mém. sur les Anim. sans Vert., part ii., 1er fasc. p. 163, pl. ii. fig. 2, pl. ix. fig. 1, 1816.

Ascidia atra, Lesueur, Descr. of several new species of *Ascidia*, Jour. Acad. Nat. Sc. Philadel., vol. iii. part 1, p. 2, pl. i. fig. 2, 1823.

Ascidia nigra, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1880-81, p. 466.

Phallusia atra, Traustedt, Vestindiske Ascidiæ Simplices, Vid. Medd. Nat. For. Kjøbenh., p. 278, 1881.

At the time when the first part of the Preliminary Report was written, I had only examined a single specimen, from Bermuda, of this curious species. Since then I have received from the Challenger Office three large specimens, probably from Station 142 (off the Cape of Good Hope). They are joined into a single mass by the fusion of the tests, chiefly at the posterior end, so that the appearance of a colony is produced. There seems to me no doubt that these Challenger specimens are the same species as Savigny's *Phallusia nigra* and Lesueur's *Ascidia atra*, although Traustedt (*loc. cit.*) appears to think otherwise. I have seen a considerable number of specimens, as in addition to those of the Challenger expedition, Mr. Moore, the curator of the Liverpool Free Public Museum, has kindly allowed me to examine the specimens in the collection made by the Rev. H. H. Higgins during the "Argo" expedition. Some of these, which were collected at Antigua and Tucaças, are very large.

One of the most striking features of this species is the test, which varies considerably in shape, and especially in the length and direction of the siphons, but is always of a very deep blue colour, almost black, and quite opaque. Sections show that this is due to the presence of very large numbers of rounded pigment corpuscles, each well filled with small dark blue pigment granules.

The apertures are distinct and prominent, but sometimes there are one or two supernumerary lobes. The test is thick and strong, but rather brittle; it contains numerous blood-vessels. The mantle is fairly muscular on the right side of the body, and the muscle bands are of a dark colour.

The branchial sac is long, and tapers to a point at the posterior extremity; it is plicated longitudinally, and is in some respects rather like that of *Ascidia translucida*. The transverse vessels are alternately wider and narrower, and occasional still wider transverse vessels are present, alternating with from five to nine of the smaller size. The internal longitudinal bars are strong, and bear each a series of large curved papillæ at the angles of the meshes, and smaller intermediate ones, which are only present in some parts of the sac. The papillæ are somewhat like those in the branchial sac of *Ascidia falcigera*. A number of the blood corpuscles found in the vessels are of a deep indigo blue colour. This gives a bluish tinge to the whole sac, and to most of the other organs of the body.

The tentacles are filiform and are few in number; they are of two sizes, placed larger and smaller alternately, and situated rather far apart.

Ascidia nigra seems to be a common and widely distributed species. Lesueur's specimens were from St. Vincent and Guadaloupe, Bay of Calicoua; and Traustedt's from St. Croix, and St. Thomas; those obtained during the "Argo" expedition were from Antigua and Tucacas; and there are some specimens in the British Museum collection from the Red Sea. The Challenger specimen from Bermuda is rather small, measuring about 6 cm. in its greatest length (antero-posterior), and 4 cm. in breadth. Those probably from Station 142 are larger, being about 10 cm. in length.

One specimen of this species is from Bermuda, shallow water, and three probably from Station 142, December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; depth, 150 fathoms; bottom temperature, 8°·3 C.; bottom, sand.

Ascidia falcigera, Herdman (Pl. XXXII. figs. 1–6).

Ascidia falcigera, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 469.

External Appearance.—The body is elliptical or nearly round in shape, and is usually depressed. The area of attachment is large, including part of the ventral edge and the entire posterior end, and extending sometimes half-way up the left side. The edge of the base is often expanded into a thin spreading margin. The apertures are on the upper (right) side, near the anterior end, and not far apart; the branchial is terminal or subterminal, the atrial is about two-fifths of the way down, and at a short distance from the dorsal edge. The branchial is almost sessile, while the atrial is slightly prominent; the lobes are very distinct, especially those around the atrial aperture.

The surface is smooth and soft, but slightly wrinkled. The colour varies from a light grey to a pale horn tint; it is darker at the apertures.

The length and breadth are variable; as an average may be taken—length of the body, 5 cm.; breadth of the body, 4 cm.

The Test is thin all over, except at the base of attachment, where it is greatly thickened, and has small stones, &c., imbedded in it. Large vascular trunks are visible in this thickened base, elsewhere the vessels are few and of small size.

The Mantle is moderately muscular, especially on the siphons and down the centre of the right side.

The Branchial Sac extends to the base of the mantle, and is not longitudinally plicated. The transverse vessels are all narrow. The internal longitudinal bars are moderately strong, and bear long tapering papillæ, which are curved like tusks, at the angles of the meshes; there are no intermediate ones; the horizontal membranes are very broad, and form large flat vesicles occupying the concave sides of the papillæ. The meshes are square, and each contains three to five regularly arranged stigmata.

The Endostyle is well marked, and of a yellow colour; it ends abruptly at the base of the ventral edge of the sac.

The Dorsal Lamina is very broad in its posterior half. It is transversely ribbed and minutely tuberculated at the edge, a larger process being placed opposite the end of each transverse rib, and there are generally a few smaller ones between.

The Tentacles are thirty-five to forty in number, they are long and touch at their bases; longer and shorter ones generally alternate, but such is not always the case.

The Dorsal Tubercle is oval or elliptical in outline. The horns almost meet, and are not turned in. The aperture is on the right side of the anterior end.

This species varies slightly in external form. Most of the specimens are more or less depressed, like those figured (Pl. XXXII. figs. 1 and 2), and vary in outline from a circular (fig. 2) to a rudely elliptical (fig. 1) shape. A few specimens, however, are not so much depressed, but rise in an oblong form, or rather as a sort of truncated pyramid, from the base to the branchial and atrial apertures, which in that case may be described as being situated respectively at the ventral and dorsal edges of the anterior end. The expanded margin of the area of attachment is present in all the specimens, and is considerably developed in some (Pl. XXXII. fig. 1); it has in most cases grown around small stones and other foreign objects, which have thus come to be imbedded in the test.

In size the specimens vary from 3 cm. in length and 2·5 cm. in breadth, to 6·5 cm. in length and 3·5 cm. in breadth.

The contrast between the test on the flat, solid, greatly thickened base, and on the thin, flexible, upper portion of the body is very great; it becomes a little thicker again around the apertures. The vessels in the thickened posterior part of the test are very large. The matrix of the test is hyaline, with small fusiform and stellate cells scattered through it; bladder-cells are few, spherical, and rather small in the outer part; a few concretions, generally branched, are also present; probably they have been formed since death.

The siphons of the mantle are rather long, and the atrial is much wider than the branchial, which is bent towards the ventral edge in the middle of its length. They are moderately muscular.

The transverse vessels in the branchial sac are very narrow, and in some places are so encroached upon by the ends of the stigmata above and below as to be reduced to zigzag tubes no thicker than the longitudinal interstigmatic vessels (Pl. XXXII. fig. 3, *tr.*).

The long curved fang-shaped or tusk-like papillæ are a characteristic feature in this sac. They are very large as compared with the size of the meshes, and the ciliation of their convex surfaces is very distinct. The broad horizontal membranes appear to be stretched over the convex side of the papillæ, and attached to their apices, thus forming the flattened vesicles seen on the under sides of the papillæ.

The ribs on the dorsal lamina, especially on its lower broad part (Pl. XXXII. fig. 4),

are well-marked membranes, which become less marked and die out as they approach the free edge; they appear to be continuations of the horizontal membranes stretching between the papillæ.

The tentacles are placed very closely; the larger ones are of considerable length (Pl. XXXII. fig. 5). The others are rather irregular, both in size and arrangement, although often they are placed alternately, as shown in figure 5.

The neural gland lying under the nerve ganglion is large, flattened, and of a yellow colour. The dorsal tubercle is very simple, and the aperture is thrown round to the right side by the anterior prolongation of the left horn (Pl. XXXII. fig. 6).

The œsophagus is short, and opens far back in the branchial sac, at the posterior extremity of the dorsal lamina. The stomach is long and fusiform, and extends ventrally and anteriorly from the œsophagus. The intestinal loop and the rectal loop are both narrow, but deep antero-posteriorly. The stomach and the first part of the intestine are entirely covered by the reproductive and renal glands. The genital ducts form a distinct line running down the intestinal loop and along the edge of the rectum. The renal vesicles contain clear yellowish-brown concretions. The ovary is much branched and ramifies over the right side of the intestine.

At first I was disposed to consider this species as being identical with Verrill's *Ascidia mollis*,[1] but though closely allied they are undoubtedly distinct. The branchial sacs especially differ considerably in details. *Ascidia falcigera* is also somewhat like *Ascidia obliqua*, Alder, in external appearance, but these species differ in the form and arrangement of the papillæ in the branchial sac.

Eight or nine specimens were obtained in the North Atlantic, to the south of Nova Scotia, at Station 49, May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; depth, 83 fathoms; bottom temperature, 1°·8 C.; bottom, gravel and stones.

Ascidia tenera, Herdman (Pl. XXXII. figs. 7–10).

Ascidia tenera, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 467.

External Appearance.—The body is oblong, or varies from oval to oblong in shape; it is flattened laterally. The posterior end is rounded, while the anterior end is rather blunt. The body is attached by the posterior third of the left side. The branchial aperture is terminal, is directed somewhat ventrally, and is sessile; the lobes are well-marked; the atrial aperture is placed to the right of the dorsal border, about one-third of the way from the anterior to the posterior end; it is sessile, and the lobes are well marked.

The surface is soft and somewhat velvety, but marked with slight creases, mostly longitudinal; near the apertures, especially the branchial, it is raised into minute pointed projections. The colour is light brownish-grey or pale horn colour.

[1] Descriptions of imperfectly known or new Ascidians from New England (American Journal of Science and Arts, ser. iii., vol. vii., 1873). This name was pre-occupied, Hancock having named a British species *Ascidia mollis* in 1870 (Ann. and Mag. Nat. Hist., ser. iv., vol. vi., p. 358).

Length of the body, 5 cm.; breadth of the body, 3 cm.

The Test is thin, soft, easily torn, and transparent. Vessels are moderately developed; the main trunks enter on the left side near the base.

The Mantle is very thin, the muscular bands are delicate, and the course of the alimentary canal is visible from both sides.

The Branchial Sac is not plicated longitudinally. There are generally five or seven smaller transverse vessels between a pair of larger ones. The internal longitudinal bars are narrow but well marked; they bear papillæ at the angles of the meshes, and smaller, more nearly conical intermediate ones. The meshes are square, and contain each three to five stigmata, generally four. The stigmata are elongate elliptical or oblong in shape, with rounded ends.

The Dorsal Lamina is rather broad, is delicately and rather distantly ribbed transversely and has the edge pectinated; there are one or two small intermediate teeth between each pair of slightly larger ones—those opposite the ends of the ribs.

The Tentacles are filiform, they are forty in number, and are of two sizes placed long and short alternately.

The Dorsal Tubercle is remarkably shallow; it is basin-shaped, with a wide anterior aperture; it is pointed posteriorly, and has the horns scarcely turned in.

This species has the shape of a typical *Ascidia*, being elongated antero-posteriorly, and attached by the posterior end of the left side (Pl. XXXII. fig. 7).

The dimensions given above are those of the largest specimen, the remaining two being a little smaller, but with much the same proportions. The specimens differ in shape, however, when the test is removed; one individual having the branchial aperture prominent and placed on a short siphon, while in others it is sessile, and does not project beyond the rounded anterior end.

The mantle and branchial sac are rather delicate; in the latter (Pl. XXXII. fig. 8) two smaller intermediate papillæ are occasionally joined by a narrow vessel dividing the mesh transversely; here and there also the stigmata are only half the normal height, so that a mesh or part of one contains two rows. This condition of the stigmata does not necessarily coexist with the narrow vessel uniting the small papillæ, either may be present without the other. Both conditions are shown in figure 8 on Pl. XXXII.

The condition of the dorsal tubercle is remarkable (Pl. XXXII. fig. 10). The dorsal ends of the peripharyngeal bands almost meet before turning posteriorly, so that no peritubercular area is formed, and the dorsal tubercle merely lies in the præbranchial zone at the anterior end of the dorsal lamina. It is very shallow, with a wide opening between the horns anteriorly.

The viscera upon the left side of the branchial sac are not large. The œsophagus is short, opens into the sac far back, and leads to a comparatively small stomach. The

intestine is large, but the intestinal loop is rather small. The ovary is considerably branched, and lies chiefly upon the right side of the loop. The spermatic vesicles are of the usual pyriform shape, and are united in twos and threes at the ends of the dichotomising vas deferens; they are found chiefly over the intestine in the lower part of the rectal loop. The genital ducts are conspicuous along the lower edge of the rectum. The renal vesicles cover the greater part of the left side of the stomach. They are large and clear-walled, and contain each one or more spherical concentrically laminated brown concretions.

This species somewhat resembles *Ascidia virginea*, O. F. Müller, but is undoubtedly distinct from it. That species differs from the present one chiefly in its greater length in proportion to the breadth, its greater number of tentacles, the absence of intermediate papillæ on the branchial sac, the shape of the tubercle, and in the condition of the dorsal lamina,—all fairly good characters.

Three specimens, one of them in good condition (the one figured on Pl. XXXII. fig. 7), were obtained from the western end of the Straits of Magellan, at Station 311, January 11, 1876; lat. 52° 50′ S., long. 73° 53′ W.; depth, 245 fathoms; bottom temperature, 7°·7 C.; bottom, mud; and two, one of them damaged, were obtained off the coast of Buenos Ayres, South America, at Station 320, February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Ascidia translucida, Herdman (Pl. XXXIII. figs. 1–6).

Ascidia translucida, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 466.

External Appearance.—The body is ellipsoidal, oblong-ovate, or oblong in shape, and is not flattened laterally; both ends are rounded. It is attached slightly by the left side near the posterior end. The apertures are sessile, and are both on the right side,—the branchial is nearly terminal and median, while the atrial is more than a third of the way down, and at a considerable distance from the dorsal edge.

The surface is smooth and glossy. The colour is a very light grey, almost transparent, and the vascular ramifications show as white markings over the left side and the margins of the right.

Length of the body, 2·2 cm.; breadth of the body, 1·2 cm.

The Test is moderately thick and solid, and is transparent. The vascular trunks enter near the centre of the left side; they are of large size and branch freely; they are clearly visible externally, except in the centre of the right side.

The Mantle is thin and membranous.

The Branchial Sac is longitudinally plicated, and shows externally a well-marked division into pouches. The internal longitudinal bars are strong, and bear rather long curved papillæ at the angles of the meshes; there are no intermediate ones. The transverse vessels are all of much the same size, and the horizontal membranes are broad. The

meshes are nearly square, the transverse extent being slightly the greater; each contains six to eight stigmata.

The Dorsal Lamina is ribbed transversely; between each pair of ribs a slighter one, extending only half way to the margin, is generally present; the edge is plain.

The Tentacles are simple and rather short and stout; they are thirty to thirty-five in number, and of two sizes, placed long and short alternately.

The Dorsal Tubercle is serpentiform, greatly elongated laterally, and disposed in a series of irregular folds; the horns at the extremities are not coiled.

In the specimen figured (Pl. XXXIII. figs. 1 and 2), the vascular ramifications in the test are very conspicuous; they show as delicate white lines spreading over the left (lower) side (fig. 2) and round the margins and the posterior end, but seem to die away on the right side, in the centre of which none are visible (fig. 1). The other two specimens in the collection have the vessels in the test more feebly developed, and they do not form so prominent a feature in the external appearance.

The apertures are distinct but not conspicuous, and their lobes are not well marked. The atrial aperture is placed very far round on the right side, being nearer to the centre than to the dorsal edge (Pl. XXXIII. fig. 1).

The plication of the branchial sac is very distinctly seen on the external surface (Pl. XXXIII. fig. 3), the pouches being large and clearly marked. The stigmata are not long, but are often pointed at their ends; shorter and more irregular ones are frequently present. The papillæ at the angles of the meshes are large (Pl. XXXIII. fig. 4), and have wide horizontal membranes attached to them.

The dorsal lamina is narrow and plain edged, but is distinctly ribbed transversely (Pl. XXXIII. fig. 6); about half the ribs are slighter than the others, and do not extend to the free edge.

The condition of the dorsal tubercle is very remarkable (Pl. XXXIII. fig. 5). Instead of forming a single large curve, with the ends more or less coiled, as is usual in the Ascidiidæ, it has a serpentine course, being thrown into a series of folds, and having its long axis directed transversely (parallel to the peripharyngeal bands). The tubercle lies in a shallow and wide peritubercular area, with a narrow but deep diverticulum extending posteriorly from its central part (Pl. XXXIII. fig. 5).

Three specimens of *Ascidia translucida* were obtained at Kerguelen Island, January 1874; depth, 28 fathoms.

Ascidia cylindracea, Herdman (Pl. XXXIII. figs. 7–9).

Ascidia cylindracea, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 714.

External Appearance.—The shape is oblong and nearly cylindrical; the posterior end is rounded and wider than the truncated anterior end; the ventral edge is nearly

straight, while the dorsal is slightly concave. The body is attached by the posterior end and the lower half of the left side. The apertures are both at the anterior end, they are distinct, and the lobes are well-marked; the branchial is towards the ventral edge, and sessile; the atrial is on the dorsal edge, forming a slight rounded projection.

The surface is smooth, but slightly creased. The colour is a light yellowish-grey.

Length of the body, 2 cm.; breadth of the body, 1·2 cm.

The Test is of moderate thickness, it is transparent, and shows vascular ramifications.

The Mantle has a well-marked musculature.

The Branchial Sac is extremely delicate, and is not plicated. The vessels are all very slender, and the transverse vessels are of much the same size throughout; the internal longitudinal bars are narrow, but well-marked, and have minute papillæ at the corners of the meshes, and connected by very narrow horizontal membranes. The meshes are nearly square, the antero-posterior extent being generally slightly the greater. The stigmata are long and narrow; they are very regular, and are placed three or four in a mesh.

The Dorsal Lamina is narrow, has a plain edge, and is scarcely ribbed; at the base a number of convoluted ribs commence, but they die out before reaching the edge.

The Tentacles are filiform; they are very long and numerous, with their bases almost touching.

This is a very elegant little species, it is well-shaped, stands erect, and is semi-transparent. The projection of the atrial aperture causes a slight concavity in the dorsal edge, and adds to the width of the blunt anterior end (Pl. XXXIII. fig. 7).

The branchial sac (Pl. XXXIII. fig. 8) is very regular, and is the most delicate one known in the genus *Ascidia;* the stigmata are long and are closely packed, reducing the transverse and fine longitudinal vessels to a very small size. Occasionally the stigmata break through a transverse vessel for a short distance, and extend for twice the usual length (see fig. 8, near *i. l.*). The internal longitudinal bars are slight, but distinct and very straight. The papillæ at the angles of the meshes are minute but rather thick; they are connected by very narrow horizontal membranes, closely attached to the transverse vessels. Occasionally very minute intermediate papillæ are present on the internal longitudinal bars for a few meshes; they are also connected by fine horizontal membranes (Pl. XXXIII. fig. 8, *tr.'*), which span the uninterrupted stigmata, a fine transverse vessel not being formed.

The dorsal lamina is narrow, and has a plain edge (Pl. XXXIII. fig. 9). A number of ribs, commencing at the ends of the transverse vessels of the branchial sac, form thickened convoluted bands on the inner part of the lamina, but they die out long before reaching the edge; in some parts they are hardly so well marked as is represented in figure 9.

In this specimen the entire lamina is distinctly marked by a network of capillary ramifications, which are engorged with blood corpuscles of a reddish-brown colour; they

are especially prominent in a band running along the lamina in about the middle of its breadth (Pl. XXXIII. fig. 9).

I was unable to make out the condition of the dorsal tubercle without cutting up the single specimen in the collection more than seemed proper.

One specimen of *Ascidia cylindracea* was trawled off Twofold Bay, Australia, at Station 163; April 4, 1874; lat. 36° 56′ S., long. 150° 30′ E.; depth, 120 fathoms.

Ascidia despecta, Herdman (Pl. XXXIII. figs. 10–12).

Ascidia despecta, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 715.

External Appearance.—The shape is oval, the anterior end being narrow while the posterior is wider and rounded. The dorsal edge is rather more convex than the ventral. The body is somewhat compressed laterally and is attached by the posterior half of the left side. The branchial aperture is terminal, or almost so; the atrial is not distant, being on the dorsal edge, about one-fourth of the way from the anterior to the posterior end; both apertures are sessile and not conspicuous.

The surface is covered with small soft projections, giving it a rough appearance. The colour is grey.

Length of the body, 1·7 cm.; breadth of the body, 1 cm.

The Test is thin, and nearly transparent, showing fine vascular ramifications. The main trunks enter near the centre of the area of attachment. At the posterior end of the left side the test is prolonged into a few short tufts for attachment.

The Mantle is of moderate thickness.

The Branchial Sac is not plicated longitudinally, and it is rather strong. The transverse vessels are narrow, and are all of much the same size. The internal longitudinal bars are stout, and bear large rod-like papillæ at the corners of the meshes; there are no intermediate ones. The meshes are slightly longer transversely than antero-posteriorly; each contains three to five stigmata, generally four.

The Dorsal Lamina is wide, and is transversely ribbed; the ribs form rather large projections on the free margin, which is otherwise plain.

The Tentacles are large and numerous, about twenty to twenty-five in number; they are all of one length.

This is a soft, roughish, dull grey species, of an ovoid form, with inconspicuous apertures. It is semi-transparent, the outline of the mantle showing through the test pretty distinctly (Pl. XXXIII. fig. 10).

The branchial sac is rather strong, the stigmata being small and the vessels thick (Pl. XXXIII. fig. 11). The transverse vessels are all of one size, and the stigmata are regular, short, and elongate-elliptical in shape. The papillæ are rod-shaped, stout, and prominent.

The dorsal lamina is wide and the ribs are strong; like those on the dorsal lamina of *Pachychlæna obesa*, they rather increase in size as they approach the free margin, on which they form considerable projections (Pl. XXXIII. fig. 12).

I was unable to determine the nature of the dorsal tubercle without injuring the unique specimen.

One specimen of *Ascidia despecta* was obtained at Kerguelen Island, in January 1874, from a depth between 10 and 100 fathoms.

Ascidia pyriformis, Herdman (Pl. XXXIV. figs. 1–6).

Ascidia pyriformis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 468.

External Appearance.—This species is irregularly pear-shaped; the anterior end is narrow and pointed, the posterior is broad and rounded. It is attached by a small area near the posterior end of the left side. The branchial aperture is terminal, and is placed on a long, somewhat conical projection, turned dorsally; the sides of this projection are channelled by eight grooves leading down from between the lobes of the aperture. A strong elevated ridge extends from the base of the branchial projection along the anterior part of the dorsal edge. The atrial aperture is sessile, and is placed at the posterior extremity of this ridge, being about half-way from the anterior to the posterior end, and directed posteriorly.

The surface is irregular; it is slightly rough, and is prolonged into a few short thickish tufts for attachment at the base; the globular posterior end is incrusted with sand and shell fragments. The colour is a dull dirty grey.

Length of the body, 5 cm.; breadth of the body, 3 cm.

The Test is remarkably thin, except on the siphons and the ridge connecting them, the latter being very thick.

The Mantle is moderately muscular over the right side of the body and on the siphons; it is membranous over the large distended left side. The body, when the test has been removed, is very peculiarly shaped. The right (branchial) side is flat, narrow, and elongated antero-posteriorly; while the edges of the mantle forming it are produced into a thin margin, which runs out at intervals, especially round the posterior end, into fine points attached to the inner surface of the test. The left (visceral) side, on the other hand, is large, globular, and distended, extending beyond the branchial area laterally, but not reaching so far posteriorly. The siphons are long and narrow, the branchial is terminal, and is directed anteriorly; the atrial is about half-way from the end of the branchial siphon to the posterior end of the body, and is directed dorsally and a little anteriorly. A crested ridge extends from the base of the branchial to the base of the atrial siphon, and similar crested ridges extend down both siphons from the lobes round the apertures. The projecting points of these ridges are received into minute pits on the inner surface of the test.

The Branchial Sac is of moderate size; it is long, pointed at the dorsal edge of the

lower end, and longitudinally plicated. The transverse vessels are narrow, and all of much the same size. The internal longitudinal bars are strong, and the papillæ are large, but of one size only. The meshes are square, and contain each three or four stigmata.

The Endostyle is conspicuous, and terminates at the base of the ventral edge of the sac.

The Dorsal Lamina is closely ribbed transversely, and the margin is bluntly serrated.

The Tentacles are very numerous and crowded; they are long and slender, varying in thickness, but all of much the same length.

The Dorsal Tubercle is very complicated, and occupies a deep triangular peritubercular area. It forms an irregularly curved and coiled pattern, with no obvious horns.

This is a very remarkable species, and in external appearance (Plate XXXIV. figs. 1 and 2) is distinctly pyriform. The dimensions given above are those of the smaller specimen; the other one measures 7·5 cm. in length, and 4 cm. in breadth; it has several Ascidians and a few other animals adhering to its test.

The greater part of the test is remarkably thin and easily torn; on the elevated ridge, however, between the siphons (Pl. XXXIV. figs 1 and 2), it is very thick. In one of the specimens a *Crenella* was found imbedded in this part of the test.

The body, when removed from the test, has a most characteristic appearance (Pl. XXXIV. fig. 3). The siphons are long, narrow, and echinated; the branchial measuring 1·2 cm., and the atrial 0·8 cm. in the smaller specimen, while in the larger they are 1·8 cm. and 1·4 cm. respectively.

On the right side of the body there is a "branchial area," defined by the extension of the mantle into a sort of free crenated border, the points between the crenations being produced into longer or shorter sharp processes. The ventral part of this branchial area is raised into a smooth rounded pad (Pl. XXXIV. fig. 3). This, at the anterior end, joins an irregular collar which surrounds the base of the branchial siphon, and is continued as a crested ridge along the dorsal edge to the base of the atrial siphon, lying under the prominent ridge which was noticed as running between the two siphons in the description of the external appearance. The large, globular, visceral side, when viewed from the right, appears outside the branchial area dorsally, and more especially ventrally.

The plication of the branchial sac is not well marked, and produces, as seen from the inside (Pl. XXXIV. fig. 4), merely a little irregularity in the position and direction of the interstigmatic vessels. The slanting direction in which the transverse vessels run in the part of the branchial sac figured (fig. 4) is not constant, but was observed in one part of the branchial sac.

The condition of the dorsal tubercle is very remarkable. The peritubercular area is triangular and deep, and its cavity is entirely occupied by a convoluted dark marking (Pl. XXXIV. fig. 5, *d.t.*), which appears to represent the dorsal tubercle. The

tentacles are numerous, and a little irregular, but not of two sizes arranged symmetrically. The dorsal lamina has its ribs very closely placed (Pl. XXXIV. fig. 6), and the edge is distinctly serrated.

Two specimens of this curious species were found at Port Jackson, Australia, at a depth of 6 fathoms.

Pachychlæna, n. gen.

Sub-genus *Pachychlæna*, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 461.

Body attached, sessile. Branchial aperture eight-lobed, atrial six-lobed.

Test cartilaginous, very thick, solid and opaque.

Branchial Sac longitudinally plicated. Internal longitudinal bars bearing large papillæ at the angles of the meshes. Stigmata straight.

Dorsal Lamina in the form of a membrane.

Tentacles simple.

Viscera large, placed on the left side of the branchial sac.

In the first part of the Preliminary Report, I distinguished the three species forming the present genus from the other species of *Ascidia*, on account of the remarkable thickness and solidity of the test. This feature suggested *Pachychlæna* as an appropriate sub-generic title. As, however, I have not recognised any other sub-genera among Simple Ascidians, and as it is objectionable to introduce new grades into classification, unless absolutely necessary, it will be more convenient to consider *Pachychlæna* of generic rank, at least until some form is found which links it to *Ascidia*. That such a form may be found I have no doubt. *Pachychlæna* and *Ascidia* are closely allied, and although the specimens of the two genera in the Challenger collection are clearly distinguishable, it is easy to imagine a species, or a series of species, uniting their characters, and forming a gradual transition from the one to the other.

The three species of *Pachychlæna* described below agree in the following particulars:—The body is sessile and attached, but of different shapes. The test is thick and opaque, and of a firm cartilaginous texture. The branchial sac is longitudinally plicated, and is of considerable thickness. The meshes are transversely elongated (Pl. XXVIII. figs. 2 and 7, and Pl. XXIX. fig. 4), and have large papillæ at their angles; no smaller intermediate papillæ are present. The specimens of two of the species were all more or less injured, so that the exact determination of the body form is impossible, but the single specimen of the remaining species, *Pachychlæna oblonga*, is in perfect condition.

Pachychlæna oblonga, Herdman (Pl. XXIX. figs. 1–9).

Pachychlæna oblonga, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 461.

External Appearance.—The body is irregularly oblong in shape, widest about the middle, and narrowing somewhat towards the anterior end, which is obtuse and flattened;

the posterior end is rather drawn out, and is attached to the interior of a large bivalve shell, which is in a three-quarters closed condition, constricting the test of the Ascidian. The branchial aperture is not terminal, but is placed on the right side near the ventral edge, and about one-fifth of the distance from the anterior end to the point where the body suddenly narrows at the mouth of the shell; it is directed ventrally, posteriorly, and to the right. The atrial aperture is on the right side, near the dorsal margin, and slightly anterior to the branchial aperture; it is directed dorsally and anteriorly.

The surface is smooth but mammillated very strongly on the anterior half and the right side, especially near the branchial aperture, where a few more sharply cut papillæ are visible.

The colour is a light smoky brown, rather deeper in tint at the anterior end.

Length of the body, 8 cm.; breadth of the body, 4 cm.

The Test is cartilaginous, thick, and of a light greyish-brown colour throughout. Vascular trunks enter the test on the left side about half-way down, and large vessels are seen ramifying on the inner surface; dark-coloured terminal twigs with swollen ends are very numerous in the outer layer. Elliptical cells, partly filled with pigment, are numerous throughout the whole test. Bladder cells are few and of small size; in the peripheral layers around the ends of the vessels, however, they are crowded, but very small.

The Mantle is moderately thick and muscular.

The Branchial Sac is longitudinally plicated. The transverse vessels, which are all nearly of one size, divide the grooves formed by the plication into rows of pouches, which are rather irregularly placed, and have no relation to the internal longitudinal bars. The meshes are transversely oblong, and contain each about eight to ten stigmata. The papillæ are large and expanded.

The Dorsal Lamina is ribbed transversely, and is strongly pectinated at the margin, a rib running out to the apex of each tooth.

The Tentacles are numerous and filiform; there are sixty-two large ones, and about the same number of very minute intermediate ones. These last are so small as to be easily overlooked; usually one is placed between each pair of large tentacles, but in some spaces there appears to be none.

The Dorsal Tubercle is large, and irregularly oval in outline; the right horn is turned outwards and the left horn inwards.

This is a well characterised and rather peculiar species. The elongated posterior portion of the test is probably accidental and due to the position of the animal in the interior of a shell (Pl. XXIX. fig. 1). Seen from the ventral aspect (Pl. XXIX. fig. 2), it seems as if the anterior end had been bent over towards the right side, thus accounting for the lateral position of the branchial aperture. The atrial aperture is only four-lobed, but this may be an individual peculiarity.

The surface, especially towards the anterior end, is raised into a series of strongly marked projections, very similar to those seen in *Ascidia mammillata*.

The test owes its dark colour partly to the small pigment cells (Pl. XXIX. fig. 3, *p.c.*) which are scattered so plentifully through its substance, and partly, especially in the peripheral part, to the vessels, which are very dark in colour. In the outer layer (Pl. XXIX. fig. 3) the swollen terminal knobs of the small twigs form a dark band. The bladder cells (fig. 3, *bl.*) are very small.

The branchial sac has a characteristic appearance; this is chiefly due to the large papillæ, which are shaped like paddles or La Crosse bats (Pl. XXIX. figs. 4 and 5), when seen from the side, but are simply rod-like or tapering when seen from above (figs. 4 and 6). The whole sac is strongly plicated, but the crests and troughs are very short, as none of the transverse vessels enter into the plication. There are wide membranous connecting ducts (Pl. XXIX. figs. 5 and 6, *c.d.*), which unite the internal longitudinal bars to the transverse vessels. The endostyle is normal.

The teeth on the free margin of the dorsal lamina are large and rather close together, and the ribs are distinctly continued out to their points (Pl. XXIX. fig. 7, *d.l.*).

The small intermediate tentacles (Pl. XXIX. fig. 9, *tn.'*) are curious; they are very minute in comparison with the others. They are present in the great majority of the interspaces, but are wanting in a few of them, one of which is seen in figure 8, immediately above the dorsal tubercle. The peritubercular area is shallow.

One specimen, in excellent condition, was obtained off East Moncœur Island, Bass Strait, at Station 162; April 2, 1874; depth, 38 to 40 fathoms; bottom, sandy.

Pachychlæna obesa, Herdman (Pl. XXVIII. figs. 1–5).

Pachychlæna obesa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 462.

External Appearance.—The shape of this species is unknown, on account of the absence of the greater part of the test; it was probably oval or irregularly spherical, and the anterior end must have been broad and irregularly rounded. The apertures are not distant, they are fairly conspicuous but depressed.

The surface is smooth and slightly mammillated. The colour is a dark earthy brown.

Length of the body, probably about 10 cm.; breadth of the body, about 6 cm.

The Test is cartilaginous, thick (8 mm.), solid, rigid and opaque; vessels are visible on the internal surface. It contains also numerous pigment cells and some bladder cells in the outer layers.

The Mantle is thick on the right (branchial) side of the body, and on the siphons, but is not very muscular; it is membranous on the large distended left (visceral) side. The siphons are long and rather narrow.

The Branchial Sac is long and narrow, and pointed at the posterior end; it is longi-

tudinally plicated, and the grooves are cut up into pouches which are seen clearly on the external surface. The transverse vessels are usually larger and smaller alternately. The internal longitudinal bars are strong, and bear large, irregular, often cleft or lobed papillæ. The meshes are transversely oblong, and each contains about six stigmata.

The Dorsal Lamina is ribbed transversely; the ribs are rather wide, and project in the form of small teeth on the free margin.

The Tentacles are filiform, slender, and of two sizes, placed large and small alternately; they are probably thirty to thirty-five in number.

This species seems closely allied to the last described one (*Pachychlæna oblonga*), but on account of the imperfect condition of both the specimens in the collection, many of the characters could not be determined. The small portion of the test remaining, suggests that the shape was more or less spherical, at least as far down as the place of attachment. The anterior end is broad. The apertures in place of being prominent are depressed (Pl. XXVIII. fig. 1), and in neither of the specimens can the number of lobes around them be determined. The depression of the apertures can scarcely be due to contraction, on account of the excessive thickness and rigidity of the test (Pl. XXVIII. fig. 1). Probably the depression was advantageous in rendering the test at the margin of the opening less solid, and thus permitting a certain amount of motion around the apertures.

The test contains many ellipsoidal pigment cells, varying from $\frac{1}{600}$ to $\frac{1}{300}$ of a millimetre in their long diameter; they are very regular in outline, and contain each one or more strongly refracting circular bodies, and some granular dark yellow pigment. These are thickly scattered throughout the test. Bladder cells are present in the outer layers, where the terminal twigs of the blood-vessels are also seen, generally filled with yellow corpuscles.

The mantle differs greatly in its thickness on the two sides of the body. It is thick on the siphons, which are necessarily long and narrow (Pl. XXVIII. fig. 1).

The branchial sac has a very different appearance according as it is viewed from the inside (Pl. XXVIII. fig. 2) or the outside (Pl. XXVIII. fig. 3). Internally the internal longitudinal bars and their curiously shaped papillæ are the most prominent features; the plication of the stigmatic part is also visible, but the pouches are indistinct (Pl. XXVIII. fig. 2). Externally, on the other hand, the pouches are the most evident characteristic (Pl. XXVIII. figs. 3 and 4), while the internal longitudinal bars are not seen. The transverse vessels are of two sizes, and the smaller ones enter into the longitudinal plications, while the larger ones interrupt it, hence the crests and troughs extend each across two meshes (Pl. XXVIII. fig. 4), and the pouches contain each two rows of stigmata (figs. 3 and 4).

The ribs on the dorsal lamina (Pl. XXVIII. fig. 5) are broad and band-like, and rather increase in width as they approach the free margin, from which they project as small teeth.

The branchial aperture is so damaged in both specimens that it is impossible to make out the exact number of tentacles and the condition of the dorsal tubercle.

Two specimens, both more or less injured, were obtained off East Moncœur Island, Bass Strait, at Station 162; April 2, 1874; depth, 38 to 40 fathoms; bottom, sandy.

Pachychlæna gigantea, Herdman (Pl. XXVIII. figs. 6–11, and Pl. XXIX. fig. 10).

Pachychlæna gigantea, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 463.

External Appearance.—The shape of this species, as far as can be made out, is irregularly oblong, the right side being larger than the left. Probably the body is attached by the posterior part of the ventral edge. The branchial aperture is eight-lobed, terminal, and placed on a large irregularly rounded projection turned towards the left side. The atrial aperture is six-lobed, and is also on a large projection, situated on the dorsal edge; from one-third to half-way down from the anterior to the posterior end. The lobes of both apertures are irregular, but prominent.

The surface is very irregular, and in some places is almost covered by foreign bodies. The colour is a warm yellowish-grey.

Length of the body, about 12 cm.; breadth of the body, 5 to 7 cm.

The Test is cartilaginous, very thick (varying from 2 mm. to 4 cm.), solid, rigid, and opaque; it is white in mass with a hyaline tint where thin, and yellowish-grey on the external surface. Large vessels ramify in the inner layer; the vascular trunks probably enter the test at the base of the right side towards the ventral edge. The terminal twigs of the vessels are sometimes slightly swollen, but scarcely knobbed; in some places they are almost covered by bundles of rod-like or tapering yellowish crystals. The bladder cells are very small, and are abundant in the outer part of the test around the small vessels, where yellow pigment cells are also present.

The Mantle is strongly muscular over the right side and on the siphons, while on the left side it is membranous. In several places, especially between the siphons and at the anterior extremity of the endostyle, it is marked with dark red.

The Branchial Sac is very thick, coarse, opaque, and of a brown colour. It is longitudinally plicated, and has the grooves broken up into pouches by the larger transverse vessels. On the external aspect of the sac certain very wide transverse vessels are connected by equally wide, irregularly placed longitudinal vessels, thus forming an external network of quadrangular meshes, each of which contains about four rows of stigmata. The internal longitudinal bars are stout and bear strong conical papillæ. The meshes are much elongated transversely, and each contains twelve to twenty stigmata.

The Endostyle is not conspicuous, it is yellowish, with a dark red line down each side.

The Dorsal Lamina is wide, and is strongly ribbed transversely, but not pectinated. It becomes wider and thinner as it approaches the œsophageal aperture, and then narrows again rapidly after passing it.

The Tentacles are long and stout, they are situated on a very strong muscular ring, and are about sixty in number; they are all of much the same size, a few are slighter than the rest, but are not placed regularly.

The Dorsal Tubercle is cordate and very large (measuring 3·5 millimetres antero-posteriorly); the horns are very long, and are both coiled inwards spirally.

The Alimentary Canal is wide. The œsophageal opening is situated at about three-quarters of the distance from the anterior to the posterior end of the branchial sac.

This large species has a characteristically solid and cartilaginous test, and may be considered the type of the genus *Pachychlæna*. In both the specimens part of the ventral edge, the posterior end, and a portion of each side is wanting. Still enough remains, taking both specimens together, to enable us to form a pretty complete idea of the original shape and proportions (Pl. XXVIII. fig. 6, which is formed by combining parts of the two).

Some parts of the surface are incrusted with a brownish Alga, while Polyzoa, Hydroids, Cirripedes, Compound Ascidians, &c., adhere to or are imbedded in the substance of the test. The proportions of the two specimens vary slightly; they are as follows:—

	Length of the body.	Greatest breadth.	Distance from the centre of the branchial to the centre of the atrial aperture.
A.	12 cm.	(Dorso-ventral) 7 cm.	4·5 cm.
B.	12·4 cm.	(Right to left side) 5·8 cm.	7 cm.

The test, which is probably the thickest and most solid known among Simple Ascidians, is light-coloured throughout; it contains numerous blood-vessels, and, in the outer layers small bladder cells and yellow pigment cells. The crystals found on the vessels in the test are rod-like or more irregular, large and of a distinct yellow colour on the larger branches, while on the terminal twigs they are smaller, tapering, disposed in radiating bunches, and generally colourless (Pl. XXIX. fig. 10). I think it is probable that all these deposits are due to post-mortem changes, caused possibly by the alcohol, and that they do not exist in the living test.

The body when removed from the test is so shrunken as only to occupy about half its cavity.[1] The siphons are very long, especially the branchial, and diverge at an angle of more than 90°. The right (branchial) side of the body is flat, while the left is enormously developed, the viscera forming a large projection. In consequence of this the body appears to have three sides,—a right and two left (one dorsal and the other ventral), —or in other words, is roughly triangular in transverse section. The cloaca is filled with light grey, gelatinous fæcal matter.

The branchial sac is peculiarly thick and opaque, and the wide network of larger vessels on the external surface (Pl. XXVIII. fig. 8, *e.l.* and *tr.*) gives it a very coarse appearance.

[1] This is after about six years' immersion in alcohol.

The longitudinal plication and the formation of pouches is very irregular, and as usual is more evident on the outer than on the inner surface of the sac. The strong internal longitudinal bars and their stout papillæ make the meshes seem smaller than they really are, an effect which is increased also by their great transverse elongation (Pl. XXVIII. fig. 7); the stigmata, however, are of a fair length. The connective ducts, between the external network of the branchial sac and the vessels of the mantle, are very wide, and are compressed so as to appear like flat bands.

The dorsal lamina is wide and strong, but it is not toothed (Pl. XXVIII. fig. 11). The tentacles (figs. 9 and 10, *tn.*) are numerous and very large. They spring from a projecting pad, which forms a ring round the base of the branchial siphon. The dorsal tubercle (Pl. XXVIII. fig. 10) is very large, and lies in a triangular peritubercular area. It is peculiar, on account of the extent to which the horns are coiled; the two spirals fill the whole internal area of the organ.

The viscera upon the left side of the branchial sac are large. The alimentary canal has the usual course, but the intestinal loop extends for a considerable distance anteriorly, and is bent round dorsally so as almost to meet the rectum, and thus enclose a large circular area which is occupied by a mass of renal vesicles. The genital organs are on the intestinal loop in its most anterior part. Their ducts are conspicuous along the posterior edge of the terminal part of the intestine.

Two specimens of this large species were obtained at Simon's Bay, Cape of Good Hope, in from 10 to 20 fathoms.

Hypobythius, Moseley.

Hypobythius, Moseley, On two new Forms of Deep-Sea Ascidians, obtained during the Voyage of H.M.S. Challenger, Trans. Linn. Soc., ser. ii., Zool., vol. i. p. 287.

Body cup-shaped or pyriform, pedunculated, attached. Apertures circular, not lobed.

Test cartilaginous, but soft and thin.

Branchial Sac not folded, and with no internal longitudinal bars. Stigmata small, rounded, and irregularly placed.

Dorsal Lamina a plain membrane.

Viscera forming a compact elongated mass on the dorsal edge of the branchial sac.

This genus was founded by Moseley in 1876, but was not characterised apart from the description of the single species then known, *Hypobythius calycodes*. A damaged specimen of a second species, *Hypobythius moseleyi*, was found recently in the collection, and is described below.

There is considerable difficulty in referring this remarkable genus to its proper position, and possibly it ought to be made the type of a fifth family of Ascidiæ Simplices, the Hypo-

bythiidæ. It certainly has no near affinities with either the Molgulidæ or the Cynthiidæ, and I have placed it here amongst the Ascidiidæ because we have no evidence that it possesses the power of reproducing by gemmation. Setting this negative character aside, the genus seems to me to be more closely allied to the Clavelinidæ than to the Ascidiidæ, and if allowed to remain in the latter family, must be regarded as an abnormal member, not conforming to some of the most important characteristics, and displaying features which show it to be an annectent form between the Ascidiidæ and the Clavelinidæ. It agrees with the latter family in having the apertures circular and not lobed, and differs from all the other Ascidiidæ in having no internal longitudinal bars in the branchial sac. Further remarks upon the peculiarities and affinities of the genus will be found below the descriptions of the two species.

Hypobythius calycodes, Moseley (Pl. XXXVII. figs. 1–5).

Hypobythius calycodes, Moseley, Trans. Linn. Soc. Lond., ser. ii., Zool., vol. i. p. 287.

This is one of the two species described by Professor Moseley in his paper "On two new Forms of Deep-Sea Ascidians, obtained during the Voyage of H.M.S. Challenger," published in December 1876. As I have been able, from an examination of the single fragmentary specimen, to add little to Mr. Moseley's excellent account of this species, I shall merely transcribe the most important parts of that description, and refer for further particulars to the original paper.

"The animal has the form of an inverted cone, compressed laterally so as to have an oval transverse section. From the apex of the inverted cone is continued a cylindrical stem, which is enlarged towards its inferior extremity (Pl. XXXVII. fig. 1). The test is hyaline and extremely transparent. Where it is simple it is thin and flexible, but in certain spots it is strengthened and rendered stiff by the presence in it of rounded or plano-convex masses or plates of denser tissue, which are tough and cartilaginous in consistence, and which are disposed over the surface of the test in a nearly symmetrical manner. These plates are extremely conspicuous when the test is held up to the light and viewed by transmitted light, because they refract the light strongly; and the pattern formed by them on the test when thus viewed has a very peculiar appearance. The disposition of the plates on the ventral surface of the body will be seen from figure 1, that on the dorsal surface from figure 2 (Pl. XXXVII.).

"A series of globular lobes range on either lateral margin of the body, and give it here considerable rigidity, and a ridge of highly condensed tissue runs across the body at the upper margin of its dorsal surface. A series of flattened plates is disposed over the inferior region of the ventral aspect of the body, while the superior region of the same aspect, covering the gill sac and perforated by the inhalent aperture, is entirely devoid of plates, very thin and flexible, and most perfectly transparent. On the dorsal aspect of the body a very large plate occupies the middle line inferiorly, whilst immediately above

it two pairs of oblong plates (Pl. XXXVII. fig. 2, *t.t.*) form a stiff shield for the principal viscera, which lie upon them. Two series of oval plates range on either side of the larger median ones, and extend up as far as the exhalent aperture. The test tunic is continued downwards from the upper region of the body to form the outer wall of the cylindrical stem, thus forming a tube. The lower end of this tube is widened out into a funnel-shaped mouth, and in the specimen had apparently been torn away from some object of attachment.

"The substance of the test is composed of transparent hyaline tissue, in which are embedded small bodies, the larger of which have a length of from ·007 to ·014 mm. They are irregular in form, sometimes crystalline, or with apparently crystalline contents. They are not sensibly altered in appearance by the action of acetic acid, and no effervescence is produced in the test tissue by that re-agent. The bodies are present in the greatest abundance in the test-tissue at the base of the stem. In the plates of denser tissue they are rather less abundant than elsewhere. The test forms a simple sac, continuous with the tubular cavity of the stem.

"The exhalent orifice is an aperture in the test, situate at the end of a short tube projecting externally on the dorsal aspect just below the nerve ganglion. Into it the ducts of the generative glands and the rectum open. The inhalent aperture was entirely obliterated in the only specimen obtained; it must have lain on the ventral aspect of the body, since the dorsal wall was intact. The arrangement of the muscular fibres and remnants of attachment of the gill sac seemed to indicate the position for it given in the figure, where it is introduced conjecturally (Pl. XXXVII. fig. 1, *br.*).

"Closely attached to the inner surface of the test-wall is a delicate tunic (the mantle) containing muscles. The muscles occur in the form of very fine bands, which have a nearly parallel course. The series of bands springing from near the region occupied by the heart, follow the curved inner surface of the test-cavity towards its superior margins. The muscles are disposed most thickly in the lateral regions. The mesial region of the dorsal surface is entirely devoid of them, but they extend over the whole ventral wall. Only the lateral fibres are indicated in the figure; they are prolonged superiorly in a horizontal direction along the upper margin of the dorsal wall of the test-cavity. The tubular cavity of the stem is filled by a core composed of muscular fibres embedded in gelatinous tissue, a prolongation of the mantle.

"Of the gill sac only a small portion remained intact *in situ*, but fragments here and there attached indicated an arrangement as shown in the figure. The small portion *in situ* lay over the nerve ganglion. The fenestrations in the membrane are small, simple, and irregular (Pl. XXXVII. fig. 4).

"The mouth is situate nearly in the middle line (fig 1, *œ.a.*). It leads by a short transparent œsophagus to a stomach (*st.*), which has opaque walls corrugated externally; and this viscus leads into a rectum which curves up to end at the exhalent aperture.

"Beneath the stomach is a tubular heart with a wide vessel leading from it downwards towards the stem (Pl. XXXVII. fig. 1, *h.*).

"In the loop formed by the œsophagus, stomach, and rectum is the large ovisac or ovary, which is circular in outline. The elongate tubular testis running parallel to the rectum in the middle line terminates posteriorly internally to the ovisac, its lower end spreading out into a series of ramifications, which appear very like large nerve fibres. The testis-tube opens into the exhalent aperture close to the rectum, as does also the oviduct, which lies to the dorsal side of the testis-tube and in the same line with it.

"The ovisac was full of very large ova, measuring as much as 1·5 millimetres in diameter. These ova, on slight pressure being applied, were discharged from the oviduct. They were found to consist of a very thick transparent test, with contents composed of oily yelk-globules, without a germinal vesicle.

"The testis was tumid, and full of an opaque white matter, which was discharged on pressure in tenacious threads composed of spermatozoa.

"The spermatozoa are very small. They were examined under a Hartnack No. 10 (immersion system). They consist of an elongate rod-like head, measuring ·005 millimetres in length, and an excessively fine tail, the length of which could not be determined. All the spermatozoa examined had a small transparent vesicle attached to one side of their heads, as shown in the figures (Pl. XXXVII. fig. 5)."

The above comprises almost the whole of Professor Moseley's description of this remarkable form, and I have only a few remarks to add. Mr. Moseley supposed that it was allied to *Boltenia*. The peduncle, however, is deceptive, and does not indicate any relationship to the Bolteninæ. The whole organisation, and especially the structure of the branchial sac, taken along with the fact that, as far as is known, reproduction is not performed by gemmation, shows that *Hypobythius* must be referred to the Ascidiidæ, among which we have already a new deep-sea pedunculated genus, *Corynascidia*.

The body form in *Hypobythius calycodes* is vase-shaped, with a moderately long peduncle attached to the narrow posterior end, while the anterior end is broad and truncated. The atrial aperture is placed on the dorsal edge near the anterior end, while the branchial aperture is indistinguishable, and must have been on the torn anterior end, but probably of much smaller size than is represented by Mr. Moseley in his restoration (Pl. XXXVII. fig. 1).

The test is cartilaginous and thin, except in certain localities, where denser cartilaginous thickenings or nodules are developed symmetrically, as seen in Plate XXXVII. figures 1 and 2. They are especially developed along the dorsal edge, outside the viscera, and it will be seen that in this locality in *Hypobythius moseleyi* also the test is somewhat strengthened.

The mantle is thin and membranous, and has a feeble but distinct musculature. The muscle bands are very fine but numerous. They run longitudinally, and are chiefly

on the sides, the dorsal edge being entirely free from them, as in *Hypobythius moseleyi*. In some places on the sides they are placed very closely, and have a curiously undulating course (Pl. XXXVII. fig. 3).

The longitudinal arrangement of the chief bands of the musculature recalls the twelve or fourteen parallel and longitudinally running muscle bands in the allied genus *Ciona*, and also the usually longitudinal arrangement of the musculature in the Clavelinidæ.

The branchial sac is the most remarkable characteristic of *Hypobythius*, and distinguishes it from all other Simple Ascidians. There are no folds, and there are no internal longitudinal bars, a condition which is only equalled in simplicity by the sac in the genus *Clavelina*. Only a single system of vessels can be recognised, branching and anastomosing so as to form a close network (Pl. XXXVII. fig. 4), the small rounded meshes of which are the stigmata. The tentacles and dorsal lamina cannot be made out.

The viscera form an elongated compact mass along the dorsal edge of the branchial sac (Pl. XXXVII. fig. 1). The alimentary canal is simple, forming a U shaped loop open anteriorly. This seems at first sight an abnormal arrangement, but if the intestine (fig. 1, *r.*) be pulled more to the left and ventrally (towards the right hand side of the figure), so as to lie upon the left side of the branchial sac, the relations of the parts of the alimentary canal will be found to be much the same as those in *Ascidia*, or any other typical Simple Ascidian.

The globular ovary and the ramified testis lie together in the intestinal loop, between the stomach and the intestine, and the oviduct and large vas deferens (called by Moseley the tubular testis) run anteriorly alongside the rectum, and on its right hand side, which, if the intestine be pulled ventrally, as suggested above, would become the dorsal side, the normal position of the genital ducts in the Ascidiidæ.

One specimen, somewhat damaged, was obtained by the trawl in the North Pacific Ocean, at Station 248; July 5, 1875; lat. 37° 41′ N., long. 177° 4′ W.; depth, 2900 fathoms; bottom temperature, 1°·1 C.; bottom, red clay, with concretions of peroxide of manganese.

Hypobythius moseleyi, n. sp. (Pl. XXXVII. figs. 6–9).

External Appearance.—The body is of an elongated pyriform shape, compressed laterally, and attached by the posterior end. The anterior end is broad and slightly rounded; the posterior is narrow, produced, and tapers to the small terminal area of attachment. The dorsal and ventral edges are long, and converge posteriorly from the end of the wide anterior extremity. The apertures are both anterior, large, and open, but sessile, and apparently not lobed; the branchial is near the ventral edge of the anterior end, and is directed anteriorly; the atrial is at the anterior extremity of the dorsal edge, and is directed anteriorly and slightly dorsally.

The surface is smooth all over. The colour is yellowish-grey, pale brown in parts.

Length of the body, 9 cm.; breadth of the body, 4 cm.

The Test is cartilaginous, but thin and almost membranous; it is slightly thickened along the dorsal edge; it is soft and easily torn, and is semi-transparent.

The Mantle is thin and membranous; it adheres closely to the inner surface of the test. The musculature is feeble; the bands are light brown in colour, but are narrow and distant.

The Branchial Sac is not folded; it is thin, but of moderate strength on account of the small size of the stigmata. The vessels form a close irregular network. The stigmata are small and circular, or polygonal, and have no definite arrangement.

The Endostyle is narrow. It is not prominent, but distinct, and extends down to the ventral edge of the narrow posterior end of the sac, and then turns and ascends the dorsal edge, as far as the œsophageal aperture, which is situated about half-way up the sac.

The Dorsal Lamina is a very narrow plain membrane, with no folds nor thickenings.

The Dorsal Tubercle is elongated antero-posteriorly; it is placed near the atrial aperture; the right horn is large, and is curved outwards to the right.

The Nerve Ganglion is small, oval, and placed a little way posterior to the dorsal tubercle; it has the rounded neural gland rather on its right side.

The Viscera.—The intestine and genitalia form an elongated compact mass along the dorsal edge of the branchial sac.

This interesting specimen was in such bad condition that at first sight it seemed like a confused mass of lacerated and entangled membranes. It has evidently been torn from end to end along the right side, and part of the mantle and branchial sac are entirely gone, while what remains is in parts displaced and hanging in shreds. Consequently it has been impossible to give the external form with precision, and no trace of the tentacles has been discovered.

The external shape is more or less pyriform, with the anterior end wide and the posterior narrow, and produced to form a short peduncle (Pl. XXXVII. fig. 6). The apertures are placed at the extremities of the anterior end, and are large circular holes apparently not lobed. The test is thin and soft. It is slightly thickened along the dorsal edge, forming a pad over the viscera corresponding to the plates (fig. 2, *t.t.*) in the last species, but no cartilaginous nodules are present. It is not modified in any way on the peduncle.

The mantle has a few narrow light brown muscular bands running chiefly longitudinally along the middle of each side. There are none down the dorsal and ventral edges. They are not crumpled as in the mantle of the last species (compare figs. 3 and 9 on Pl. XXXVII.), and the arrangement is very suggestive of the musculature of some of the Clavelinidæ.

The branchial sac (Pl. XXXVII. fig. 7) is very simple, being formed by a network of vessels, all similar, and having no symmetrical arrangement. There are no folds, and no internal longitudinal bars.

The dorsal lamina is a simple narrow membrane, projecting from the dorsal line of the branchial sac, and having its surface in direct continuity with that of the neighbouring vessels (Pl. XXXVII. fig. 7, *d.l.*).

The dorsal tubercle is rather large (Pl. XXXVII. fig. 8, *d.t.*) and has the right horn curved outwards, while the left is rudimentary. The posterior end is rounded, and the anterior aperture is almost obliterated. The nerve ganglion is roundish or subtriangular, and gives off numerous nerve trunks (Pl. XXXVII. fig. 8, *n.g.*). The neural gland (*n. gl.*) is large and ovate, and lies to the right side of the ganglion. It is connected with the dorsal tubercle by a distinct duct.

The viscera form an elongated mass on the dorsal edge of the branchial sac, below the thickened part of the test, and are arranged very much as in *Hypobythius calycodes.*

The single fragmentary specimen of *Hypobythius moseleyi* was obtained in the South Atlantic, off the coast of Buenos Ayres, at Station 320; February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W.; depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Ciona, Fleming.

Ascidia, Linnæus, Sys. Nat., 12th Edit. 1766. In part.
Ascidia, O. F. Müller, Zool. Dan., vol. ii. 1780. In part.
Phallusia, Savigny, Mém. Anim. sans Vert. Pt. ii. fasc. 1. 1816. In part.
Ciona, Fleming, British Animals. 1828.
Ascidia, Forbes and Hanley, British Mollusca, vol. i. 1853. In part.
Ciona, Hancock, On the larval state of *Molgula*, &c., Ann. Mag. Nat. Hist., ser. iv. vol. vi. 1870.
Ciona, Heller, Untersuch. ü. d. Tun. d. adriat. Meeres, Abth. ii. 1875.
Ciona, Kupffer, Jahresber. d. Commiss. 1875.
Ciona, Traustedt, Oversigt over de fra Danmark, &c., Ascidiæ Simplices, Kjøbenhavn. 1880.

Body sessile, attached; branchial aperture eight-lobed, atrial six-lobed.

Test gelatinous or cartilaginous, but soft.

Mantle with the musculature chiefly in the form of a small number of distinct longitudinally running bands.

Branchial Sac not plicated; internal longitudinal bars papillated; stigmata straight.

Dorsal Lamina in the form of languets.

Tentacles simple.

Intestine lying on the left side of the body, and extending beyond the branchial sac posteriorly.

Savigny, in his "Mémoires," divided the genus *Phallusia* into three tribes:—the Phallusiæ Pirenæ, the Phallusiæ Simplices, and the Phallusiæ Cionæ; the last of which he characterised as having the branchial sac shorter than the mantle and the viscera

extending beyond the branchial sac posteriorly. In this section he placed the two species *Ascidia intestinalis*, Linnæus, and *Ascidia canina*, O. F. Müller.

In 1828, Fleming ("British Animals," p. 468), adopting Savigny's term, founded the genus *Ciona*, for the common British species *Ciona intestinalis*. For a considerable time, however, this name was not received, and we find in Forbes and Hanley's "British Mollusca" (1853), the two species *intestinalis* and *canina* still retained in the genus *Ascidia*.

Things remained in this condition till 1870, when Hancock (Ann. and Mag. of Nat. Hist., ser. iv., vol. vi.) revived *Ciona* as a generic name, gave it a full and satisfactory definition, and added a new species, *Ciona fascicularis*. The name has since been used by Kupffer, Heller, and Traustedt, and may now be considered as firmly established.

The body in *Ciona* is always sessile and attached, and is usually elongated antero-posteriorly. The test is soft and almost gelatinous, being flaccid and transparent when living. The musculature of the mantle is equally developed upon both sides of the body, and is rather characteristic. A few strongly marked bundles—twelve to fourteen in *Ciona intestinalis*—are found running longitudinally from the bases of the siphons at the anterior end to the opposite extremity of the body. The other muscle bands, which are transverse and oblique, are very much weaker and more irregularly arranged. On account of the strength of the longitudinal bands, and the softness of the test, the body has very great powers of contraction.

The branchial sac is neither folded nor plicated when living and expanded, but usually when a specimen, which has been put into alcohol living, and has contracted its whole body forcibly, is examined, the branchial sac is found to be crumpled and corrugated, so as to give very much the appearance of "minute plication." This is merely caused, however, by the pressure of the surrounding mantle, and when that has been removed the sac may be spread out so as to assume more the look of its natural structure.

The most characteristic features of *Ciona* are the dorsal lamina, which is in the form of languets, like those of *Corella*, and the alimentary and genital viscera, which are situated upon the left side of the branchial sac, as in *Ascidia*, but extend beyond it posteriorly, so as to form a rudimentary abdomen. In this last character *Ciona* differs from both *Corella* and *Ascidia*, and shows affinity with *Ecteinascidia* and some of the other Clavelinidæ.

This genus contains only a small number of species. In addition to *Ciona canina*, O. F. Müller, *Ciona intestinalis*, Linnæus, and *Ciona fascicularis*, Hancock, which have been mentioned above, there remain the *Ascidia corrugata* of the "Zoologia Danica," which is probably either *Ciona canina* or *Ciona intestinalis*, Alder's[1] *Ascidia pulchella*, which may possibly be merely a variety of *Ciona intestinalis*, and Verrill's[2] *Ciona*

[1] Observations on British Tunicata, Ann. and Mag. Nat. Hist. ser. iii., vol. xi., 1863.

[2] Description of some imperfectly known and new Ascidians from New England, Amer. Journ. of Sci. and Arts, ser. iii., vol. i., No. 2, 1871.

tenella, which is also closely allied to *Ciona intestinalis*. Finally, the Challenger expedition has discovered two new species, which I have dedicated to the founders of the genus, Savigny and Fleming.

Ciona flemingi, Herdman (Pl. XXXIV. figs. 7–10).

Ciona flemingi, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 461.

External Appearance.—The body is somewhat pyriform and elongated; the anterior end is wide, and the posterior much narrower, forming a short stalk turned ventrally, and attached to some foreign body by the extremity of its right side. The apertures are situated at the anterior end, and are inconspicuous; the branchial is near the ventral edge, the atrial is near the dorsal edge; they are equally far forward, the most anterior point of the body being placed between them.

The surface is smooth; the colour is light grey.

Length of the body, 2·2 cm.; breadth of the body, 8 mm.

The Test is thin, soft, and almost gelatinous; it is transparent, the body showing through distinctly. The vessels are few.

The Mantle is normal; the musculature is rather feebly developed, consisting chiefly of a few straight bundles running longitudinally.

The Branchial Sac is rather thick, small, and shrunken-looking. The transverse vessels are all of much the same size. The internal longitudinal bars are coarse and strong; they are much crumpled, and bear irregular knob-like papillæ at their intersections with the transverse vessels; no intermediate papillæ are present. The meshes have their greatest extent longitudinal, and contain each two to three elongate-elliptical stigmata.

The Dorsal Lamina is reduced to a series of languets. Each is short and stout, and has a hook or tusk-like form.

The Tentacles are simple, all of one length, and twelve in number.

The Dorsal Tubercle is cordate, small, and has both horns turned inwards.

The Viscera extend beyond the branchial sac posteriorly.

This little species seems to be distinct from the few species hitherto referred to the genus. The body form, the short languets, and the small number of tentacles, are all very characteristic features. The short stalk mentioned above is very slight (Pl. XXXIV. fig. 7), and is merely the narrowed posterior end of the body. It is not sufficient to affect the general statement that the body is sessile in *Ciona*.

The musculature of the mantle is not very strong, but takes the form of longitudinal bands so characteristic of the genus.

The branchial sac, when first opened, showed the contracted and irregularly crumpled condition so frequently seen in spirit specimens of *Ciona intestinalis*, and caused by the pressure of the strongly contracted mantle lying over it.

The internal longitudinal bars and the papillæ are very strong and coarse, and the former are placed pretty close together (Pl. XXXIV. fig. 8), so as to bound long narrow meshes, each usually containing two stigmata only.

The languets along the dorsal line of the sac are very short, and are curved so as to have a hooked shape (Pl. XXXIV. fig. 9). The tentacles are very few, and are all of one size.

The dorsal tubercle (Pl. XXXIV. fig. 10) is simple, and is very similar to that of *Ciona intestinalis.*

One specimen of this species was dredged off Gomera, Canary Islands, February 10, 1873, in 78 fathoms.

Ciona savignyi, n. sp. (Pl. XXXV. figs. 1 and 2).

External Appearance.—The shape is probably oblong and nearly cylindrical, like that of *Ciona intestinalis;* the posterior end of the body is rounded and broad. The dorsal and ventral edges are nearly straight, tapering somewhat anteriorly. The body is attached by the left side at what would probably be one-third of the way forwards from the posterior end in the fully expanded condition. The apertures are rather close, terminal, and inconspicuous through contraction.

The surface is smooth, except at the posterior end of the left side and the ventral edge. The colour is whitish grey, hyaline where the test is thin.

Length of the body, 1·3 cm.; when expanded, probably 2 to 2·5 cm. ; breadth of the body, 1·2 cm.

The Test is moderately thick and strong, but is transparent. Vessels are present, but not conspicuous.

The Mantle is thin, but strong; and the musculature is well developed. A few strong longitudinal bands of fibres run down nearly the whole length of the body to the posterior end, and are crossed by closer, but weaker, chiefly transverse, fibres, which are not arranged in broad bands.

The Branchial Sac is rather strong, and is not plicated. The alternate transverse vessels are wider than the intermediate ones. The internal longitudinal bars are narrow, and bear large paddle-shaped papillæ at the angles of the meshes, and no intermediate ones. The meshes are rather larger transversely than longitudinally, and contain each about five rather large stigmata; each mesh is generally divided transversely by a narrow horizontal membrane connecting the internal longitudinal bars, but not interrupting the stigmata.

The Endostyle is conspicuous, undulating, and opaque white.

The Dorsal Lamina is formed by a series of rather large and close-set languets.

The Tentacles are filiform, and are rather long and numerous.

The Viscera extend posteriorly for a short distance beyond the branchial sac, and form the posterior end of the body.

The single specimen of this *Ciona* is contracted into an almost square body; the whole anterior end, to the extent of probably nearly half the total length, is retracted, and the test forms a raised pad all round the slightly sunken area in which the apertures are found (Pl. XXXV. fig. 1). A similar condition is often produced in *Ciona intestinalis* by sudden immersion of the living animal in alcohol.

The specimen is attached to a fragment of some kind of fibrous plant by the left side of the body, nearly two-thirds of the distance from the posterior to the anterior end, or at what would in the expanded condition be about one-third of the way up. The posterior end is free and rounded, and is pretty broad; the anterior end, judging from the distance between the apertures, must have been narrow.

The test is strong, but transparent, the wide intestine showing through distinctly at the posterior end of the left side; along the dorsal edge of the right side it is considerably roughened, rising here and there into slight tufts and processes.

The mantle is muscular, and resembles that of *Ciona intestinalis* more than *Ciona flemingi*. The longitudinal bands are well-marked, and are often double.

In the branchial sac the papillæ are very large and expanded, being of the wide paddle shape found in several species of *Ascidia*. The stigmata are large, and considerably wider than the fine longitudinal interstigmatic vessels; they frequently break through the slighter transverse vessels, and extend from one larger vessel to the next (Pl. XXXV. fig. 2). Wide horizontal membranes extend from papilla to papilla, along the transverse vessels, and narrower ones are often present, dividing the meshes transversely between the papillæ, but not interrupting the stigmata.

The languets are large, and form a conspicuous fringe along the dorsal edge of the branchial sac. The endostyle is white and conspicuous, and the tentacles are long.

On account of the great state of contraction of the anterior end of the specimen, and especially of the siphons, I was unable to make out satisfactorily the condition of the dorsal tubercle. To the naked eye it seemed small and compact, and is probably simply rounded or cordate, like the tubercles of *Ciona intestinalis* and *Ciona flemingi*.

One specimen of *Ciona savignyi* was dredged off Kobé, Japan, at Station 233A; May 17 to 19, 1875; lat. 34° 35′ N., long. 135° 10′ E.; depth, 8 fathoms and 50 fathoms; bottom, mud and sand.

Family Clavelinidæ.

Body fixed, posterior end usually prolonged into a short stalk, which may give off creeping stolons; never coated with sand grains.

Test gelatinous, rarely cartilaginous. Apertures usually not lobed, or only indistinctly so.

Branchial Sac not folded; internal longitudinal bars usually absent, when present they are not papillated; stigmata straight.

Tentacles simple, filiform.
Intestine always extending beyond the branchial sac posteriorly.
Genitalia placed in the intestinal loop. Reproduction by gemmation is also usual, and results in the formation of colonies.

For a detailed account of my reasons for considering the Clavelinidæ as Simple Ascidians, I must refer to the second part of the Preliminary Report.[1] It will be sufficient here to mention that in organisation the Clavelinidæ are most closely allied to the Ascidiidæ; that if we consider only the structure of a single individual, an *Ecteinascidia* might be placed in the same genus with a *Ciona*, and that the property of reproducing by gemmation and forming colonies is really the only essential character which separates the Clavelinidæ from the Ascidiidæ; and finally, that this property of budding cannot be considered as forming a strict line of demarcation, since all the apparatus necessary for the process is present in a more or less developed condition in other Simple Ascidians, and has been observed in species of *Ascidia* [2] and *Ciona* [3] to produce stolons similar to those of a *Clavelina*. On account of their property of reproducing by gemmation the Clavelinidæ must be considered as having a closer affinity to the Compound Ascidians than have any others of the Simple Ascidians. They form a passage between such forms as *Ciona* in the Ascidiidæ and *Diazona* in the Compound Ascidians.

The Challenger genus *Ecteinascidia* is an interesting connecting link between the other Clavelinidæ and the Ascidiidæ. It forms colonies by gemmation, and therefore belongs to the Clavelinidæ, but in the rest of its characters it more closely approaches *Ciona* than *Clavelina*.

The curious form which Philippi described in 1843, under the name of *Rhopalæa*, must for the present remain unplaced as to family. It was described as a Simple Ascidian,[4] but the account given of it and the figures published certainly suggest that it belongs to the Clavelinidæ, and will probably find a place near *Ecteinascidia*. In opposition to this view, the internal longitudinal bars of *Rhopalæa* are figured as being distinctly papillated, a condition of things of which I have never seen a trace in any specimen of *Ecteinascidia*. For a determination of the affinities of this interesting species we must be content to wait till we have some information as to the important point of whether it possesses the property of reproducing by gemmation.

Setting *Rhopalæa* aside, there remain three genera which undoubtedly belong to this family, viz. :—*Clavelina*, *Ecteinascidia*, and *Perophora*, each of which is represented by several species. The three genera are very distinct, and are easily separated from one

[1] Proc. Roy. Soc. Edin., 1879–80, p. 714.

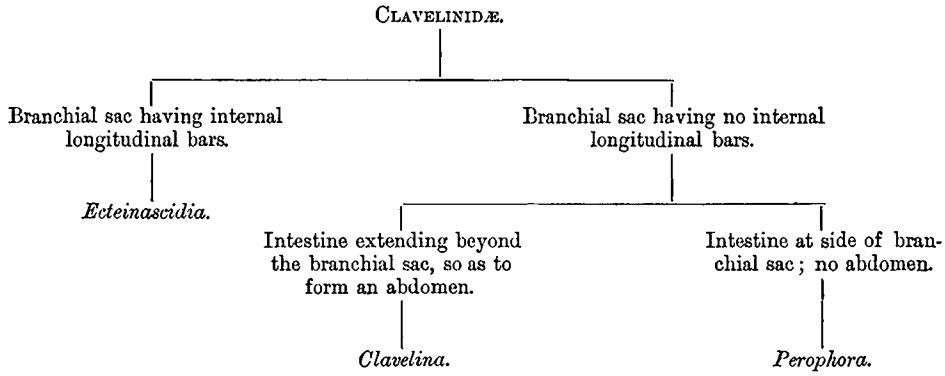
[2] I have found specimens of *Ascidia aspersa*, O. F. Müller, with long stolon-like processes extending from the test at the posterior end and left side of the body.

[3] *e.g.*, frequently in large individuals of *Ciona intestinalis*, Linnæus.

[4] This was subsequent to the publication of Milne-Edwards' Memoir creating the group of Social Ascidians.

another. *Clavelina* and *Ecteinascidia*, though differing so decidedly in the structure of the branchial sac, are rather more closely allied than is either of them to *Perophora*, which agrees, however, with *Clavelina* in the absence of internal longitudinal bars. In the shape of the branchial sac and its relations to the viscera, *Perophora* may be compared to *Ascidia*, while *Ecteinascidia* and *Clavelina* represent *Ciona* amongst the Ascidiidæ; even in *Perophora*, however, the intestine sometimes extends slightly beyond the branchial sac posteriorly.

These three genera may be distinguished briefly thus :—



The Challenger collection contains two species of *Clavelina*, and three other forms which necessitated the formation of the genus *Ecteinascidia*. *Perophora* is not represented.

Ecteinascidia, Herdman.

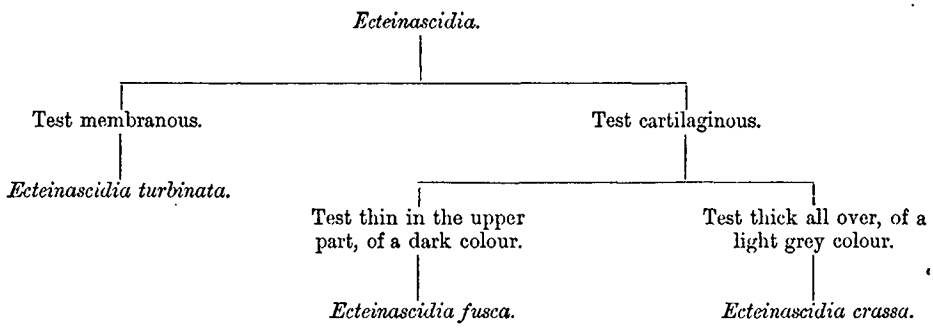
Ecteinascidia, Herdman, Prelim. Rep., Proc. Roy Soc. Edin., 1879–80, p. 722.

Body oblong, usually tapering posteriorly. Apertures indistinctly lobed.
Test cartilaginous or membranous.
Mantle thin, musculature moderately strong.
Branchial Sac having internal longitudinal bars, but no papillæ; stigmata straight.
Dorsal Lamina in the form of languets.
Tentacles simple.
Viscera extending beyond the branchial sac posteriorly.

This genus was formed for the reception of three new species of colony-forming Simple Ascidians, with non-papillated internal longitudinal bars in their branchial sacs. This character distinguishes them from both *Perophora* and *Clavelina*, and necessitated the formation of a new genus.

Ecteinascidia has its nearest ally in *Clavelina*, and is intermediate in its characters between that genus and *Ciona*, thus leading towards the Ascidiidæ. The three species differ considerably in external appearance, and are also easily distinguished by the structure of their branchial sac and other internal organs.

They may be separated, according to the conditions of their tests, by the following table :—



Ecteinascidia crassa, Herdman (Pl. XXXVI. figs. 12–14).

Ecteinascidia crassa, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 723.

External Appearance.—The body is irregular in shape, it is rudely triangular, or rather of a flattened pyramidal form, and is attached by an extended base to a clump of sponge spicules. The anterior end is narrow but more or less rounded. The sides are irregular; the posterior end is wide and expanded. The apertures are both near or at the anterior end, they are sessile and inconspicuous, and no lobes are visible.

The surface is rather irregular, but not rough. The colour is a warm grey, slightly yellowish in places.

Length of the body, 1·6 cm.; breadth of the body (at the posterior end), 1·5 cm.

The Test is strong, cartilaginous, and very thick.

The Mantle is strongly developed, and the muscle bands are thick.

The Branchial Sac has delicate but distinctly marked undulating internal longitudinal bars, borne on large triangular connecting ducts. No papillæ are present. The transverse vessels are all of one size, and are rather wide. The stigmata are elongate-elliptical in shape, and are very regular. The meshes are nearly square, and contain generally three stigmata each.

The Dorsal Lamina is in the form of languets.

The Viscera extend considerably beyond the branchial sac, and form a distinct abdomen.

This is a small and rather irregular species, which differs notably in external appearance from the other two species, inasmuch as its posterior end is wide, and expands into a broad base in place of tapering to form a short stalk.

A second specimen in the collection differs somewhat in its proportions from the one figured (Pl. XXXVI. fig. 12) and described above. Its dimensions are as follows:—length, 2 cm.; breadth at the posterior end, 3·5 cm. Consequently, in this specimen the base is even broader than in the other, and exceeds the length of the body.

The test in this species is solid, and is in one of the specimens enormously developed, forming a large mass, in which the body of the individual is imbedded. The anteriorly placed apertures are both sessile, and have no visible lobes.

The branchial sac is strongly contracted and rather crumpled. The stigmata are shorter than, but similar in shape to, those of the other two species (Pl. XXXVI. fig. 13). The internal longitudinal bars are very fine, and are slightly undulated; they are attached to the summits of very large triangular flaps or connecting ducts, which hang from the wide transverse vessels (Pl. XXXVI. figs. 13 and 14).

The tentacles are simple and filiform, but I was unable, without injuring the single specimen examined, to determine their number, and the condition of the dorsal tubercle. These are points, however, of secondary importance, and the species is, I believe, sufficiently characterised without them.

The alimentary and genital viscera extend in this species for a considerable distance beyond the branchial sac, so as to form a distinct abdomen, which is almost as large as the thorax, and is connected with it by a narrow pedicle traversed by the œsophagus, the intestine, and the genital ducts.

Two specimens of *Ecteinascidia crassa* were found attached to the spicules of a large Hexactinellid sponge, dredged off Ki Island, at Station 192; September 26, 1874; lat. 5° 42′ S., long. 132° 25′ E.; depth, 129 fathoms; bottom, mud.

Ecteinascidia fusca, Herdman (Pl. XXXVI. figs. 7–11).

Ecteinascidia fusca, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 723.

External Appearance.—The individuals of this species are united into a colony by a short thick irregular stolon. The shape of each individual is very elongated, some are rudely club-shaped. The anterior end is wide and truncated; the posterior half is narrower, contorted, and passes down into the stolon. The apertures are nearly terminal, both are placed upon the right side of the extremity; the branchial is near the middle, and the atrial near the dorsal edge.

The surface is smooth but uneven, especially at the posterior end, where knobs and processes are usually present. The colour is dark brown.

Length of the body, 4·7 cm.; breadth of the body, 1·5 cm.

The Test is cartilaginous, stiff, opaque, and thickish, especially in the posterior part, sometimes it is rather thin at the anterior end. Vessels are present.

The Mantle is thin; the muscular bands are distant, but well-marked, and are of a reddish-brown colour. The larger bundles run longitudinally.

The Branchial Sac is delicate. The internal longitudinal bars are narrow but distinct; they are undulating, and are supported by broad horizontal membranes, provided with triangular flaps, to the apices of which the bars are attached. There are no papillæ. The transverse vessels are narrow, and all of one size. The meshes are regular, elongated antero-posteriorly, and contain each about three long and regular stigmata, with parallel sides and rounded ends.

The Dorsal Lamina is represented by a series of long narrow languets, with undulating edges, and tapering to a fine point.

The Tentacles are filiform, few, and distant.

The Dorsal Tubercle is irregularly oval in outline.

The Viscera are prolonged beyond the branchial sac posteriorly, and extend into the narrow posterior part of the body.

This is a strong and moderately large species (Pl. XXXVI. fig. 7). The individuals or Ascidiozooids are united by a short rough stolon, which is merely a prolongation of their posterior ends. On this stolon the test is very thick and strong; while over the anterior part of the body it is usually thinner; in one individual the dark-brown longitudinally running muscle bands of the mantle show through distinctly. The posterior part of the body, into which the intestine is prolonged, is much narrower than the anterior or branchial region. The apertures are both near the anterior end, and are not far apart. They are sessile, but distinct, and are lobed, though usually only indistinctly and irregularly. When most distinct, the lobes seem to be six round the atrial aperture and seven or eight round the branchial.

The appearance of the mantle is rather characteristic, the dark reddish brown muscle bands showing very distinctly as fine distant lines on the thin membrane.

The branchial sac (Pl. XXXVI. fig. 8) is rather like that of *Ecteinascidia crassa;* it differs from it chiefly in the stigmata being longer, while the transverse vessels are relatively narrower, and in having the large triangular connecting ducts or flaps of the horizontal membranes shorter and placed rather further apart (Pl. XXXVI. figs. 8 and 13). In *Ecteinascidia crassa* the points of these flaps, when laid down on the sac (fig. 13), extend past the tops of the stigmata of the next row, while in the present species they only extend three-quarters of the way down the stigmata of their own row (fig. 8). In consequence of the length of the stigmata, the meshes in the present species are elongated antero-posteriorly, while in the *Ecteinascidia crassa* they are square (compare figs. 8 and 13, Pl. XXXVI.). The stigmata are usually very regular, with rounded ends. Figure 9 shows a slight irregularity which was noticed.

The languets in this species are long and narrow, tapering gradually to a point. When stretched out, each overlaps the succeeding one by about half its length (Pl. XXXVI. fig. 11, *l.*). They are arranged down the centre of a wide membranous area which runs

along the dorsal edge of the branchial sac, and is crossed transversely by the horizontal membranes which bear the languets. At each side of this membranous area, just where the stigmata commence, is a row of smaller languets, exactly similar in size, shape, and position to the triangular flaps which support the internal longitudinal bars; these two rows, however, at the sides of the dorsal lamina, have no bars attached to their apices (Pl. XXXVI. fig. 11).

The tentacles are not numerous, and are all of one length (Pl. XXXVI. fig. 10, *tn.*). They spring from a circular band of muscular fibres which forms the posterior end of the branchial sphincter.

The dorsal tubercle is ovate in outline, and lies in a shallow peritubercular area, out of which it projects fully half way across the præbranchial zone to the base of the tentacles (Pl. XXXVI. fig. 10, *d.t.*). The neural gland and the ganglion form a rounded opaque mass, situated immediately posteriorly to the dorsal tubercle.

One colony of *Ecteinascidia fusca*, formed of several individuals, was obtained at Banda, Moluccas; depth, 17 fathoms.

Ecteinascidia turbinata, Herdman (Pl. XXXVI. figs. 1–6).

Ecteinascidia turbinata, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 724.

External Appearance.—In this species many individuals are united into a colony by delicate, much-branched, but short stolons. The shape of each individual is elongated, and sometimes almost pyriform. The anterior three-fourths is nearly cylindrical, while the posterior part tapers rapidly to a short slender stalk, continuous with the stolon. The anterior end is broad, truncated or rounded. The apertures are sessile and minute, they are both at the right side of the anterior end, and are not lobed.

The surface is smooth. The colour is a light yellowish-brown.

Length of the body, 3 cm.; breadth of the body (near the anterior end) 1 cm.

The Test is thin and membranous; it is transparent.

The Mantle is thin.

The Branchial Sac is simple. The internal longitudinal bars are narrow, but well marked, they are borne on stout connecting ducts; there are no papillæ. The transverse vessels are all of one size, and are very wide; no horizontal membranes are present. The meshes are greatly elongated antero-posteriorly, and contain each two or three long narrow stigmata.

The Dorsal Lamina is represented by a series of tentacular languets.

The Tentacles are simple and filiform, and are of three lengths placed alternately; there are about twenty of the long and twenty of the medium size, and forty of the short ones.

The Dorsal Tubercle is elongated, and tapers posteriorly. The aperture is anterior, and the horns are coiled.

The Viscera extend slightly beyond the branchial sac posteriorly.

This is a very elegant species, and differs from the two other species of *Ecteinascidia* externally in its more definite shape and the delicacy of its test. The individuals are united by their narrow posterior ends to a delicate, much-branched stolon (Pl. XXXVI. fig. 2). They are attached to this stolon at short intervals, and consequently are crowded pretty closely together, forming large colonies (Pl. XXXVI. fig. 1). Buds of various sizes are also found here and there attached to the stolons (fig. 2). The shape of the individuals or ascidiozooids varies from cylindrical to conical, the anterior end being broad and rounded, while the posterior is narrow. The test is very thin and quite transparent, allowing the viscera to be seen through distinctly.

The branchial sac is rather different from those of *Ecteinascidia crassa* and *Ecteinascidia fusca*. The transverse vessels are extremely wide, and have no horizontal membranes attached to them (Pl. XXXVI. fig. 3). The internal longitudinal bars are narrow, and are borne on strong but short connecting ducts, which widen out as they approach the bar, and are narrow where they join the transverse vessels. They are very different from the wide triangular flaps found in *Ecteinascidia crassa* and *Ecteinascidia fusca*. The meshes are much elongated antero-posteriorly, and the stigmata are narrower in comparison to the interstigmatic vessels than in the other two species of *Ecteinascidia*.

The languets (Pl. XXXVI. fig. 6, *l.*) are of moderate length, are rather distantly placed (about their own length apart), and are tentacular in shape, in place of being triangular and flattened antero-posteriorly as usual. The membranous area on which they are placed is much narrower than in *Ecteinascidia fusca*, but has a band of muscular fibres running down its centre (fig. 6).

For a short distance on each side of this dorsal membranous area there is no internal longitudinal bar, although short papillæ are seen projecting from the transverse vessels in a longitudinal row on each side, and evidently representing the connecting ducts (Pl. XXXVI. fig. 6, *c.d.*).

The tentacles are very dissimilar, the longest ones being about seven times as long as the shortest. The intermediate ones are scarcely half the length of the longest ones. Calling them A, B, and C, they are found to be arranged alternately thus :—A, C, B, C, A, &c. (Pl. XXXVI. fig. 4, *tn.*, *tn.'* and *tn.''*). The elongated dorsal tubercle tapers from the anteriorly placed aperture so as to become carrot-shaped.

On account of the length of the branchial sac, the alimentary and genital viscera only extend slightly beyond its posterior end. The stomach is small, and forms the posterior end of the visceral mass. The intestine after leaving it runs for a short distance anteriorly, and then slopes across the left side of the posterior part of the branchial sac from the ventral to the dorsal edge, along which it is continued anteriorly, as the conspicuous dark-coloured rectum, towards the anteriorly placed atrial aperture (Pl. XXXVI. figs. 1 and 2).

The genital glands occupy the intestinal loop; the ovary is placed alongside, and

curved parallel with the intestine, and the testis is in the concavity of the ovary (Pl. XXXVI. fig. 5). The vas deferens has a remarkable course. It arises from the side of the testis opposite to the ovary and intestine, and runs for a short distance away from these organs towards the dorsal edge. It then turns anteriorly, and converges towards the rectum, which it crosses close to the anus (fig. 5, *v.d.*).

In the Liverpool Free Public Museum there are several colonies of *Ecteinascidia turbinata*, from Alexandria Harbour; 3 to 5 fathoms.

The Challenger expedition obtained one large colony, of about twenty adult individuals and some buds, at Bermuda, in shallow water.

Clavelina, Savigny.

Ascidia, O. F. Müller, Zoologia Danica, vol. ii. 1780. In part.
Ascidia, Cuvier, Mém. du Mus., t. ii. 1815. In part.
Clavelina, Savigny, Mémoires sur les Animaux sans Vertèbres, 2nd partie, 1st fasc., p. 87; and Tableau Systematique, p. 171. 1816.
Clavelina, Milne-Edwards, Observations sur les Ascidies Composées des côtes de la Manche. Mém. Inst. France, t. xviii. 1842.
Clavelina, Giard, Recherches sur les Synascidies, Arch. Zool. expér. et génér., t. i. 1872.

Body oblong, more or less stalked.
Test gelatinous or cartilaginous. Apertures circular, not lobed.
Mantle thin.
Branchial Sac with no internal longitudinal bars; stigmata straight.
Dorsal Lamina in the form of languets.
Tentacles simple.
Viscera extending beyond the branchial sac posteriorly.

In 1816, Savigny founded this genus for the reception of two species, which had previously been classed under *Ascidia*, viz.:—*Ascidia borealis*, Savigny (= *Ascidia clavata*, Pallas), and *Ascidia lepadiformis*, Müller. He characterised the genus in his "Mémoires" as including pedunculated Simple Ascidians with a gelatinous test. In the "Tableau Systematique" (p. 171), he gives a full diagnosis, which might almost stand unmodified as the definition of the genus as used at the present day. It is as follows:—

"*Corps* pédiculé par la base, à enveloppe gélatineuse ou cartilagineuse.

"*Orifice branchial* dépourvu de rayons; *l'anal* de même.

"*Sac branchial* non plissé, très-court, et n'arrivant pas au milieu de la tunique, surmonté de filets tentaculaires simples; les mailles du tissu respiratoire dépourvues de papilles.

"*Abdomen* totalement inférieur. *Foie* nul ou peu distinct des parois de l'intestin. Point de côte s'étendant du pylore à l'anus.

"*Ovaire* unique, compris dans l'abdomen."

Savigny seems not to have known of the power of budding possessed by the Clavelinidæ, and as far as the genus *Clavelina* was concerned, Milne-Edwards was the first, in

his great work on the Compound Ascidians, to show that they reproduced by gemmation, although long before Lister[1] had pointed out the same fact in another genus of the family, *Perophora*.

Milne-Edwards gave a very full account of the anatomy and physiology of *Clavelina*, and described several species at considerable length. He proposed that *Clavelina* and *Perophora* should be separated from the Simple Ascidians, with which up till that time (1842) they had been associated, and he formed for their reception a group, the Ascidiæ Sociales, intermediate between Simple and Compound Ascidians, and independent of both.

Giard, in his "Recherches sur les Synascidies," published in 1872, adds little or nothing to Milne-Edwards's account of the genus *Clavelina*, which he places along with *Perophora* and the Compound Ascidians, in his Synascidiæ.

Clavelina is the typical genus of the Clavelinidæ, and shows most of the characteristic features of the family in a marked degree. It differs from *Perophora* chiefly in the relation of the intestine to the branchial sac, and in having a more or less well developed abdomen. From *Ecteinascidia* it is separated by the total absence of internal longitudinal bars in the branchial sac.

The two new species of *Clavelina* discovered during the Challenger expedition differ somewhat from the previously known species of the genus in the external appearance of the colony, as in both cases the individuals are crowded together, and the stolons are present merely in the form of a thick mass of test substance continuous with and uniting the posterior ends of the individuals.

Clavelina oblonga, Herdman (Pl. XXXV. figs. 6–10).

Clavelina oblonga, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 724.

External Appearance.—The individuals are closely united into a colony by their posterior ends, which form a thick irregular stolon. The shape of each ascidiozooid is irregularly oblong, sometimes club-shaped or more irregular. The anterior end is wide and rounded; the posterior is generally very narrow. The apertures are sessile, not lobed, and are placed both at the anterior end.

The surface is smooth, with occasional transverse wrinkles, especially towards the posterior end. The colour is light yellowish-grey, nearly white.

Length of the body of a single individual, 2 cm.; breadth of same, 0·6 cm.; height of the colony, 6 cm.

The Test is thin, especially at the anterior end; it is transparent.

The Mantle is moderately strong. The margins of the apertures are much pigmented, but not so as to form definite ocelli.

[1] Philosophical Transactions for 1834. Part II.

The Branchial Sac is simple. The transverse vessels are all of one width; they bear horizontal membranes. No internal longitudinal bars are present. The stigmata are short, and elongate-elliptical in shape. The interstigmatic vessels are strong.

The Dorsal Lamina is reduced to a series of languets. These are short, conical, and tentacular, and are separated by about their own length. They spring from a narrow membranous band.

The Tentacles are short and stout; they are about twenty in number, placed long and short alternately.

The Dorsal Tubercle is small and irregularly oval in outline; the horns project laterally at the anterior end.

This species forms a very elegant-looking colony of an elongated shape (Pl. XXXV. fig. 6). The posterior ends of the individuals are in close contact, and sink into a common base or stolon, which forms the axis of the colony. The bodies of the separate individuals are more or less club-shaped on account of the anterior end being much wider than the posterior.

The test is of a soft cartilaginous consistency, intermediate between the thin gelatinous test of *Clavelina lepadiformis*, and the thick cartilaginous one of *Clavelina enormis*.

The branchial sac, though simple, is not delicate (Pl. XXXV. fig. 7); the interstigmatic fine vessels are strong, and nearly as broad as the stigmata. The transverse vessels are moderately wide, and bear plain, not very wide horizontal membranes, which when laid out flat scarcely cover even the tops of the stigmata immediately below them. The ciliated stigmatic cells are short and rounded (Pl. XXXV. fig. 9, *sg.c.*).

The languets are short and stout, and are placed on a narrow membranous band extending along the dorsal edge of the branchial sac. Their bases are continuous with the horizontal membranes of the transverse vessels (Pl. XXXV. fig. 8).

The tentacles are short but strong. The larger ones are swollen about half-way up. In one place two shorter tentacles occurred between a pair of larger ones (Pl. XXXV. fig. 10, *tn.'*).

One colony of this species, consisting of about forty individuals, was dredged at Bermuda, in shallow water.

Clavelina enormis, Herdman (Pl. XXXV. figs. 3–5).

Clavelina enormis, Herdman, Prelim. Rep., Proc. Roy. Soc. Edin., 1879–80, p. 725.

External Appearance.—The individuals are united into a colony by their posterior ends, which form a common base of irregular shape. The shape of each individual is rudely oblong. The anterior end is wide, but irregular. The apertures are sessile, inconspicuous, and not lobed; they are both at the anterior end.

The surface is smooth, but irregular, especially on the posterior part. The colour is greyish, with a slight brown tinge.

Length of the body of a single individual, 3 cm.; breadth of the same, 0·7 cm.; height of the colony, 4 cm.

The Test is cartilaginous and opaque; it is moderately thin on the anterior half; posteriorly it is thicker, wrinkled, and incrusted with sand.

The Mantle is well developed.

The Branchial Sac is simple, but rather strong. The transverse vessels are all of one size, with wide horizontal membranes hanging from them. No internal longitudinal bars are present. The stigmata are regular, short, and narrow, with rounded ends. The fine interstigmatic vessels are stout.

The Dorsal Lamina is represented by a series of very large triangular languets, placed closely.

The Tentacles are stout, and of two sizes, placed long and short alternately; there are about twelve of each size.

This is an irregular species, and the only specimen in the collection is almost certainly to some extent abnormal (Pl. XXXV. fig. 3). The united posterior ends of the ascidiozooids form a common irregularly-shaped base, which has probably been hypertrophied by, and owes its irregularity to, adhering to the surface of a mass of *Balani*.

The test is cartilaginous and strong. It is thick posteriorly and on the base, but is much thinner at the anterior extremities of the individuals, and on their thoracic or branchial regions. Two of the individuals are united together along one side by their tests, which thus form a common investing mass. This is of course an abnormality, probably caused merely by the very close proximity of the two individuals.

The branchial sac is strong, the stigmata being slight and the transverse and interstigmatic vessels stout; the latter are usually twice as broad as the stigmata (Pl. XXXV. fig. 4). The horizontal membranes hanging from the transverse vessels are very wide, and when laid out flat reach three-quarters of the way to the next transverse vessel, covering the greater part of the row of stigmata between (Pl. XXXV. fig. 4). The stigmata are very regular.

The languets in this species are very different from those seen in *Clavelina oblonga* (compare figs. 5 and 8 on Pl. XXXV.). Here they are numerous, placed close together, thin and membranous, triangular in shape, and of large size. They spring from a broad dorsal membranous band, and their bases are continuous with the broad horizontal membranes extending round the branchial sac.

One colony of this curious *Clavelina*, consisting of four adult individuals and several buds, was obtained at Simon's Bay, Cape of Good Hope, in 10 to 20 fathoms.

GEOGRAPHICAL DISTRIBUTION.

We know as yet very little as to the Geographical Distribution of the Tunicata—far too little to make generalisations of much value. Still it will be useful to future investigators to tabulate what has been already determined, even if in many cases it shows merely negative results. But it must be borne clearly in mind, when examining the following statements, that only a very small area of the sea bottom was examined at each Station, and that Tunicates might very possibly be abundant in a locality from which none are here recorded.

I have divided the track of the Challenger round the world into a series of comparatively short stages, so as to show roughly the localities between which the different observing Stations lie. These stages are arranged in the order in which they were traversed by the expedition, and consequently the Stations are in chronological order, and the lists of species occur in the order in which they were collected. The chief objects of this arrangement are to show—(1), the approximate positions of the Stations at which Tunicates were obtained, and (2), the list of species from each Station.

Between England and the Canary Islands the following Tunicate was dredged :—

Off Gomera, the Canary Islands, 10th February 1873 ; depth, 75 fathoms.

Ciona flemingi.

Between the Canary Islands and the West Indies no Tunicata were obtained.

Between the West Indies and Halifax the following Tunicata were obtained :—

Off Bermuda, June 1873 ; in shallow water.

Ascidia nigra.
Ecteinascidia turbinata.
Clavelina oblonga.

Station 44, May 2, 1873 ; lat. 37° 25′ N., long. 71° 40′ W.; depth, 1700 fathoms ; bottom temperature, 1 ·7 C.; bottom, grey ooze.

Culeolus perlatus.

Station 48, May 8, 1873 ; lat. 43° 2′ N., long. 64° 2′ W.; depth, 51 fathoms ; bottom, rock.

Boltenia elegans.[1]

[1] The label in the bottle is marked Le Have Bank, Nova Scotia, 75 fathoms.

Between Halifax and Bermuda the following Tunicate was dredged:—

Station 49, May 20, 1873; lat. 43° 3′ N., long. 63° 39′ W.; depth, 83 fathoms; bottom temperature, 1°·8 C.; bottom, gravel and stones.

Ascidia falcigera.

Between Bermuda and the Canary Islands no Tunicata were obtained.

Between the Canary Islands and Bahia the following Tunicate was obtained:—

Off Bahia; depth, 7 to 20 fathoms.

Polycarpa pilella.

Between Bahia and the Cape of Good Hope no Tunicata were obtained.

Between the Cape of Good Hope and Kerguelen Island the following Tunicata were collected:—

Simon's Bay, Cape of Good Hope; depth, 10 to 20 fathoms.

Cynthia pallida.
Pachychlæna gigantea.
Clavelina enormis.

Station 142, December 18, 1873; lat. 35° 4′ S., long. 18° 37′ E.; depth, 150 fathoms; bottom temperature, 8°·3 C.; bottom, sand.

Ascidia nigra (?).[1]

Station 146, December 29, 1873; lat 46° 46′ S., long. 45° 31′ E.; depth, 1375 fathoms; bottom temperature 1°·5 C.; bottom, globigerina ooze.

Culeolus recumbens.
Corynascidia suhmi.

Station 147, December 30, 1873; lat. 46° 16′ S., long. 48° 27′ E.; depth, 1600 fathoms; bottom temperature, 0°·8 C.; bottom, globigerina ooze.

Culeolus perlucidus.
Fungulus cinereus.
Bathyoncus mirabilis.

Between Kerguelen Island and Melbourne, Australia, the following Tunicata were collected:—

Station 149, off Kerguelen Island, January 1874; depth, 10 to 110 fathoms.

January 19, 1874; Balfour Bay, 20 to 60 fathoms.

Ascidia challengeri.

[1] It is the locality which is doubtful, not the name of the species.

20th January 1874; Royal Sound, 28 fathoms.

Ascidia challengeri.
vasculosa.
translucida.

29th January 1874; off London River, 110 fathoms.

Eugyra kerguelenensis.

No date; off Kerguelen, 10 to 100 fathoms.

Eugyra kerguelenensis.
Styela lactea.
Ascidia challengeri.
despecta.

Station 150, February 2, 1874; lat. 52° 4′ S., long. 71° 22′ E.; depth, 150 fathoms; bottom temperature, 1°·8 C.; bottom, rock.

Ascopera gigantea.
pedunculata.
Molgula pedunculata.
Styela grandis.
convexa.
Polycarpa minuta.
Ascidia placenta.

Station 160, March 13, 1874; lat. 42° 42′ S., long. 134° 10′ E.; depth, 2600 fathoms; bottom temperature, 0°·2 C.; bottom, red clay.

Styela bythia.
squamosa.
Abyssascidia wyvillii.

Between Melbourne and New Zealand the following Tunicata were collected:—

Station 162, April 2, 1874; off East Moncœur Island, Bass Strait; depth, 38 to 40 fathoms; bottom, sand.

Microcosmus polymorphus.
propinquus.
Cynthia fissa.
hispida.
Styela radicosa.
Polycarpa rigida.
molguloides.
Pachychlæna oblonga.[1]
obesa.

[1] The label on the bottle containing this specimen is marked 85 fathoms.

Station 163, April 4, 1874; lat. 36° 56′ S., long. 150° 30′ E.; depth, 2200 fathoms; bottom temperature, 0°·7 C.; bottom, red clay. Trawled in 120 fathoms,[1] off Twofold Bay.

Polycarpa radicata.
Ascidia cylindracea.

Port Jackson, Australia; 17th April to 23rd May 1874; 2 to 20 fathoms.

Molgula forbesi.
Cynthia cerebriformis.
irregularis.
complanata.
Styela gyrosa.
exigua.
Polycarpa tinctor.
viridis.
longisiphonica.
radicata.
Ascidia pyriformis.

Canterbury, New Zealand.

Boltenia pachydermatina.

Between New Zealand and the Fiji Islands the following Tunicata were collected:—

Station 170, July 14, 1874; lat. 29° 55′ S., long. 178° 14′ W.; depth, 520 fathoms; bottom temperature, 6°·0 C.; bottom, rock.

Culeolus wyville-thomsoni.

Kandavu, the Fiji Islands; July 27, 1874.

Cynthia pallida.

Between the Fiji Islands and Hong Kong, China, the following Tunicata were dredged:—

Station 186, September 8, 1874; lat. 10° 30′ S., long. 142° 18′ E.; depth, 8 fathoms; bottom, coral sand.

Cynthia arenosa.
formosa.[2]

Station 188, September 10, 1874; lat. 9° 59′ S., long. 139° 42′ E.; depth, 28 fathoms; bottom, mud.

Microcosmus helleri.

[1] The two Ascidians are almost certainly from this depth.
[2] This species is labelled "Torres Straits, 3 to 11 fathoms."

Station 192, September 26, 1874; off Ki Island, lat. 5° 42′ S., long. 132° 25′ E.; Noon; depth, 129 fathoms; bottom, mud.

Polycarpa quadrata.
Ecteinascidia crassa.

Banda, Malay Archipelago, October 1, 1874; depth, 17 fathoms.

Polycarpa sulcata.
Ecteinascidia fusca.

Between Hong Kong and New Guinea the following Tunicata were collected:—

Hong Kong, China; depth, 10 fathoms.

Corella japonica.

Station 208, January 17, 1875; lat. 11° 37′ N., long. 123° 32′ E.; depth, 18 fathoms; bottom, mud.

Polycarpa irregularis.

Station 212, January 30, 1875; lat. 6° 55′ N., long. 122° 15′ E.; depth, 10, 14 and 20 fathoms; bottom, sand.

Polycarpa pedata.

Between New Guinea and Japan the following Tunicata were dredged:—

Station 233A, May 17 to 19, 1875; Kobé, Japan; lat. 34° 35′ N., long. 135° 10′ E.; depth, 8 fathoms and 50 fathoms; bottom, mud and sand.

Styela clava.
Corella japonica.
Ciona savignyi.

Off Yokohama, Japan; shallow water.

Corella japonica.

Between Japan and the Sandwich Islands the following Tunicata were obtained:—

Station 241, June 23, 1875; lat. 35° 41′ N., long. 157° 42′ E.; depth, 2300 fathoms; bottom temperature, 1°·1 C.; bottom, red clay.

Culeolus murrayi.

Station 248, July 5, 1875; lat. 37° 41′ N., long. 177° 4′ W.; depth, 2900 fathoms; bottom temperature, 1°·1 C.; bottom, red clay.

Hypobythius calycodes.

Between the Sandwich Islands and Valparaiso the following Tunicata were collected:—

Papiete Harbour, Tahiti, Society Islands; depth, 10 to 20 fathoms.

Cynthia papietensis.

Station 271, September 6, 1875; lat. 0° 33′ S., long. 151° 34′ W.; depth, 2425 fathoms; bottom temperature, 1°·0 C.; bottom, globigerina ooze.

Culeolus moseleyi.

Station 299, December 14, 1875; lat. 33° 31′ S., long. 74° 43′ W.; depth, 2160 fathoms; bottom temperature, 1°·1 C.; bottom, grey mud.

Corynascidia suhmi.

Between Valparaiso and the Falkland Islands the following Tunicata were dredged:—

Station 311, January 11, 1876; lat. 52° 50′ S., long. 73° 53′ W.; depth, 245 fathoms; bottom temperature, 7°·7 C.; bottom, mud.

Ascidia tenera.

Station 312, January 13, 1876; lat. 53° 38′ S., long. 70° 56′ W.; depth, 15 to 10 fathoms; bottom, mud.

Boltenia legumen.

Station 313, January 20, 1876; lat. 52° 20′ S., long., 68° 0′ W.; depth, 55 fathoms; bottom temperature, 8°·8 C.; bottom, sand.

Molgula gigantea.
Ascidia meridionalis.

Between the Falkland Islands and Buenos Ayres, South America, the following Tunicata were collected:—

Station 315, January 26, 27, 28, 1876; lat. 51° 40′ S., long. 57° 50′ W.; depth, 5 to 12 fathoms; bottom, sand and gravel.

Molgula gregaria.
horrida.
Boltenia legumen.

Station 316, February 3, 1876; lat. 51° 32′ S., long. 58° 6′ W.; depth, 4 to 5 fathoms; bottom, mud.

Boltenia legumen.

Station 320, February 14, 1876; lat. 37° 17′ S., long. 53° 52′ W. (off the coast of Buenos Ayres); depth, 600 fathoms; bottom temperature, 2°·7 C.; bottom, hard ground.

Molgula pyriformis.
Styela flava.
oblonga.
glans.
Ascidia meridionalis.
tenera.
Hypobythius moseleyi.

Between Buenos Ayres and England no Tunicata were obtained.

The above arrangement has given, of course, information as to the bathymetrical distribution, as well as the geographical, but a better general notion of the latter alone may be obtained by grouping the above Stations at which Tunicata were collected into geographical regions, as is shown in the following list.[1] The principal object in this case is to give the Tunicate Fauna of each of these regions, as known from the Challenger investigations.

In the North Atlantic (East) the following Tunicate was found :—

Off Gomera, Canary Islands.

Ciona flemingi.

In the North Atlantic (West) the following Tunicata were obtained :—

Off Bermuda.

Ascidia nigra.
Ecteinascidia turbinata.
Clavelina oblonga.

At Station 44.

Culeolus perlatus.

At Station 48.

Boltenia elegans.

At Station 49.

Ascidia falcigera.

Off the east coast of South America the following Tunicate was dredged:—

Off Bahia.

Polycarpa pilella.

At the Cape of Good Hope and neighbourhood the following Tunicata were collected :—

At Simon's Bay.

Cynthia pallida.
Pachychlæna gigantea.
Clavelina enormis.

At Station 142 (?).

Ascidia nigra.

[1] In this case all details as to the exact position, depth, temperature, &c., of the Stations have been omitted, as these have already been given in full in the first list.

Off Kerguelen Island and in the neighbourhood the following Tunicata were collected:—

At Station 146.

Culeolus recumbens.
Corynascidia suhmi.

At Station 147.

Culeolus perlucidus.
Fungulus cinereus.
Bathyoncus mirabilis.

At Station 149, Kerguelen Island.

Eugyra kerguelenensis.
Styela lactea.
Ascidia despecta.
challengeri.
vasculosa.
translucida.

At Station 150.

Ascopera gigantea.
pedunculata.
Molgula pedunculata.
Styela grandis.
convexa.
Polycarpa minuta.
Ascidia placenta.

Off South Australia and New Zealand the following Tunicata were collected :—

At Station 160.

Styela bythia.
squamosa.
Abyssascidia wyvillii.

At Station 162.

Microcosmus polymorphus.
propinquus.
Cynthia fissa.
hispida.
Styela radicosa.
Polycarpa rigida.
molguloides.
Pachychlæna oblonga.
obesa.

At Station 163.

Polycarpa radicata.
Ascidia cylindracea.

At Port Jackson, Australia.

Molgula forbesi.
Cynthia cerebriformis.
irregularis.
complanata.
Styela gyrosa.
exigua.
Polycarpa tinctor.
viridis.
longisiphonica.
radicata.
Ascidia pyriformis.

From Canterbury, New Zealand.

Boltenia pachydermatina.

In the Southern Pacific Area the following Tunicata were dredged :—

At Station 170.

Culeolus wyville-thomsoni.

At Kandavu, Fiji Islands.

Cynthia pallida.

At Station 271.

Culeolus moseleyi.

In the seas of the Malay Archipelago the following Tunicata were dredged :—

At Station 186.

Cynthia arenosa.
formosa.

At Station 188.

Microcosmus helleri.

At Station 192.

Polycarpa quadrata.
Ecteinascidia crassa.

At Banda.

Polycarpa sulcata.
Ecteinascidia fusca.

Off Hong Kong, China.

Corella japonica.

At Station 208.

Polycarpa irregularis.

At Station 212.

Polycarpa pedata.

Off Japan the following Tunicata were dredged :—

At Station 233A.

Styela clava.
Corella japonica.
Ciona savignyi.

Off Yokohama.

Corella japonica.

In the Northern Pacific Area the following Tunicata were dredged :—

At Station 241.

Culeolus murrayi.

At Station 248.

Hypobythius calycodes.

In Papiete Harbour, Tahiti, Society Islands.

Cynthia papietensis.

Off the Southern end of South America the following Tunicata were collected :—

At Station 299.

Corynascidia suhmi.

At Station 311.

Ascidia tenera.

At Station 312.

Boltenia legumen.

At Station 313.

Molgula gigantea.
Ascidia meridionalis.

At Station 315.

Molgula gregaria.
horrida.
Boltenia legumen.

At Station 316.

Boltenia legumen.

At Station 320.

Molgula pyriformis.
Styela flava.
oblonga.
glans.
Ascidia meridionalis.
tenera.
Hypobythius moseleyi.

This list seems to show that Tunicata are very much more abundant at some localities (*e. g.*, Station 150, Station 162 and Station 320) than at others; but it must be noted that in some cases, such as Kerguelen Island, the length of the list is caused, to a certain extent, by the much greater time spent by the expedition in investigating that region. Some of the areas in the above list, however, at which there were a large number of observing stations, show singularly few Ascidians. For example, in the eastern portion of the North Atlantic, and off the east coast of South America, only a single species was obtained in each locality. Then again, only three species were found in the South Pacific Area, and only two in the North Pacific. On the other hand, some much smaller areas have a long list of species,—for example, fifteen species were obtained in the neighbourhood of Kerguelen Island, and twenty-three in the area comprising Australia and New Zealand.

In the table given below, the geographical regions already made use of have been grouped together to form seven great areas, namely:—the North Atlantic, the South Atlantic, the Southern Ocean (the region lying to the south of the Indian Ocean, and including Kerguelen Island), the seas of the Malay Archipelago (the area lying between Australia and China), the North Pacific, the South Pacific, and the shores of the southern end of South America. This last area has been separated from the South Atlantic and South Pacific Oceans, to which it should strictly belong, because of the large number of Tunicata found in the neighbourhood of Cape Horn, and the difficulty of dividing them into an east coast and a west coast series.

As the species are arranged in systematic order, this table shows at a glance the distribution of any particular species, genus, or family in the great ocean basins.

TABLE SHOWING THE DISTRIBUTION OF THE FAMILIES, GENERA, AND SPECIES OF ASCIDIÆ SIMPLICES THROUGHOUT THE GREAT OCEAN BASINS.

SPECIES.	1. North Atlantic.	2. South Atlantic.	3. Southern Ocean.	4. Seas of Malay Archip.	5. North Pacific.	6. South Pacific.	7. Seas of South America.
Family MOLGULIDÆ.							
Ascopera gigantea,			+				
pedunculata,			+				
Molgula gigantea,							+
gregaria,							+
pedunculata,			+				
horrida,							+
forbesi,						+	
pyriformis,							+
Eugyra kerguelenensis,			+				
Family CYNTHIIDÆ.							
Boltenia elegans,	+						
legumen,							+
pachydermatina,						+	
Culeolus murrayi,					+		
wyville-thomsoni,						+	
recumbens,			+				
perlucidus,			+				
perlatus,	+						
moseleyi,						+	
Fungulus cinereus,			+				
Microcosmus helleri,				+			
propinquus,						+	
polymorphus,						+	
Cynthia cerebriformis,						+	
fissa,						+	
formosa,				+			
arenosa,				+			
irregularis,						+	
pallida,		+				+	
papietensis,					+		
complanata,						+	
hispida,						+	
Styela bythia,						+	
squamosa,						+	
grandis,			+				
gyrosa,						+	
convexa,			+				

Species.	1. North Atlantic.	2. South Atlantic.	3. Southern Ocean.	4. Seas of Malay Archip.	5. North Pacific.	6. South Pacific.	7. Seas of South America.
Styela lactea,			+				
exigua,						+	
clava,					+		
radicosa,						+	
oblonga,							+
flava,							+
glans,							+
Bathyoncus mirabilis,			+				
Polycarpa pedata,				+			
viridis,						+	
tinctor,						+	
minuta,			+				
molguloides,						+	
quadrata,				+			
pilella,		+					
rigida,						+	
longisiphonica,						+	
irregularis,				+			
sulcata,				+			
radicata,						+	
Family Ascidiidæ.							
Corynascidia suhmi,			+				+
Corella japonica,				+	+		
Abyssascidia wyrillii,						+	
Pachychlæna oblonga,						+	
obesa,						+	
gigantea,		+					
Ascidia meridionalis,							+
challengeri,			+				
vasculosa,			+				
translucida,			+				
tenera,							+
pyriformis,						+	
falcigera,	+						
cylindracea,						+	
despecta,			+				
nigra,	+	+					
placenta,			+				
Hypobythius calycodes,					+		
moseleyi,							+
Ciona flemingi,	+						
sarignyi,					+		

Species.	1. North Atlantic.	2. South Atlantic.	3. Southern Ocean.	4. Seas of Malay Archip.	5. North Pacific.	6. South Pacific.	7. Seas of South America.
Family Clavelinidæ.							
Ecteinascidia crassa,				+			
fusca,				+			
turbinata,	+						
Clavelina oblonga,	+						
enormis,		+					

The preceding table shows—first, that the Challenger expedition obtained Simple Ascidians in all of the seven great areas into which the seas of the globe have been divided; and secondly, that they were much more abundant in the Southern Pacific Ocean[1] than in any of the other regions.

Of the Molgulidæ, *Ascopera* and *Eugyra* are confined to the Southern Ocean, while *Molgula* is found in the Southern Ocean and also in the South Pacific, and round the southern end of South America. Hence the family is not represented[2] in the Atlantic Ocean, the North Pacific, and the Seas of the Malay Archipelago.

The great family Cynthiidæ has representatives in all the oceanic areas—and the Bolteninæ also occupy them all, with the exception of the South Atlantic and the Seas of the Malay Archipelago.

The Cynthinæ are chiefly from the South Pacific area, but are also represented in the North Pacific, the South Atlantic, and the Malay regions, while they are entirely absent in the North Atlantic, the Southern Ocean, and round the southern end of America.

The Styelinæ are also chiefly from the South Pacific Ocean, but are represented in all the other areas, with the exception of the North Atlantic.

The Ascidiidæ are entirely wanting only from the Seas of the Malay Archipelago, and they are pretty equally distributed over the other six regions.

The Clavelinidæ, finally, occur in the North Atlantic, the South Atlantic, and the Malay region, and are unrepresented in the remaining four areas.

In the following table, the last illustrating the geographical distribution of the Ascidiæ Simplices, the occurrence of the different genera and species according to the latitude is

[1] This region is of much greater extent than the "Southern Pacific Area" used previously (page 257), and includes, in addition to it, the Australian region, in which a large number of species were obtained.

[2] All these statements as to distribution refer, of course, to the Challenger collection only.

shown in both northern and southern hemispheres. A + means merely that the species opposite which it is placed was found by the Challenger expedition somewhere between the limits of latitude which the column represents. Hence it may indicate more than one occurrence of the same species.

North Latitude.					Genus. Species.	South Latitude.				
45°–40°	40°–30°	30°–20°	20°–10°	10°–0°		0°–10°	10°–20°	20°–30°	30°–40°	40°–45°
					Ascopera gigantea,					+
					pedunculata,					+
					Molgula gigantea,					+
					gregaria,					+
					pedunculata,					+
					horrida,					+
					forbesi,				+	
					pyriformis,				+	
					Eugyra kerguelenensis,					+
+					*Boltenia elegans,*					
					legumen,					+
					pachydermatina,					+
	+				*Culeolus murrayi,*					
					wyville-thomsoni,			+		
					recumbens,					+
					perlucidus,					+
	+				*perlatus,*					
					moseleyi,	+				
					Fungulus cinereus,					+
					Microcosmus helleri,	+				
					propinquus,				+	
					polymorphus,				+	
					Cynthia cerebriformis,				+	
					fissa,				+	
					formosa,		+			
					arenosa,		+			
					irregularis,				+	
					pallida,		+		+	
		+			*papietensis,*					
					complanata,				+	
					hispida,				+	
					Styela bythia,					+
					squamosa,					+
					grandis,					+
					gyrosa,				+	
					convexa,					+
					lactea,					+

North Latitude.								Genus. Species.	South Latitude.					
45°	40°	40°	30°	30°	20°	20°-10°	10°-0°		0°-10°	10°-20°	20°	30°	30°-40°	40°-55°
								Styela exigua,					+	
		+						*clava,*						
								oblonga,					+	
								flava,					+	
								glans,					+	
								radicosa,					+	
								Polycarpa viridis,					+	
								tinctor,					+	
								minuta,						+
								molguloides,					+	
								quadrata,	+					
								pilella,		+				
								rigida,					+	
								longisiphonica,					+	
						+		*irregularis,*						
								sulcata,	+					
							+	*pedata,*						
								radicata,					+	
								Bathyoncus mirabilis,						+
								Corynascidia suhmi,					+	+
		+		+				*Corella japonica,*						
								Abyssascidia wyvillii,						+
								Pachychlæna obesa,					+	
								gigantea,					+	
								oblonga,					+	
								Ascidia challengeri,						+
								vasculosa,						+
								placenta,						+
		+						*nigra,*					+	
								meridionalis,					+	+
+								*falcigera,*						
								tenera,					+	+
								translucida,						+
								cylindracea,					+	
								despecta,						+
								pyriformis,					+	
				+				*Ciona flemingi,*						
		+						*savignyi,*						
		+						*Hypobythius calycodes,*						
								moseleyi,					+	
								Clavelina enormis,					+	
		+						*oblonga,*						
		+						*Ecteinascidia turbinata,*						
								fusca,	+					
								crassa,	+					

This table brings out very forcibly—first, the great preponderance of Ascidians in the southern over the northern hemisphere, there being about six times as many entries on the right hand side of the table as on the left; and secondly, the abundance of Tunicata in the far south, the two last divisions on the right hand side (30° to 40° and 40° to 55°) 25° in all, containing each of them more entries than all the other divisions, both north and south latitude, taken together.

Consequently, it appears from the Challenger investigations that Simple Ascidians are not abundant in the northern hemisphere, and are comparatively scarce in tropical latitudes, while they attain their greatest numerical development in southern temperate regions.

Taking up particular groups of species, we find that the Challenger Molgulidæ were all obtained in the southern hemisphere, and between the latitudes of 30° and 55° S. Two species of *Molgula* were found between 30° and 40° S., while all the rest, including the genera *Ascopera* and *Eugyra*, and most of the species of *Molgula*, are from latitudes between 40° and 55° S.

The Cynthiidæ range over both hemispheres, extending from between 40° and 45° north latitude, to between 50° and 55° south latitude. The sub-family Bolteninæ has an equally extended range, but is most abundant in the far south. The number of species found in the extreme right hand column (40° and 55° south latitude) equal those in all the other columns put together.

In the genus *Boltenia*, one species occurs in the extreme north, while the other two are from far south, the genus being unrepresented in intermediate latitudes.

The genus *Culeolus* has also a very considerable horizontal range, two of the species, *Culeolus murrayi* and *Culeolus perlatus*, being found in the northern hemisphere, while the remaining four are from the southern. Those in the northern seas are from the temperate zone, while of the southern forms, one, *Culeolus moseleyi*, is from near the equator; one, *Culeolus wyville-thomsoni*, from between 20° and 30° south latitude, and the remaining two species are from much further south. The nearly allied *Fungulus cinereus* is also from high latitudes in the southern hemisphere.

The sub-family Cynthinæ is, with the exception of *Cynthia papietensis*, confined to the southern hemisphere, but none extend beyond the parallel of 40°. *Microcosmus* has one species near the equator, while the remaining two are from much further south. In the genus *Cynthia*, also, most of the species are from the Southern temperate zone, three only being found in tropical latitudes.

The sub-family Styelinæ is represented by three species north of the equator, while the remaining twenty-two are from the southern hemisphere, and the great majority of them from south of 30° S. latitude.

In the genus *Styela*, all the species, with the exception of one (*Styela clava*) from the northern hemisphere, are from the southern temperate region, and most of them are from between the parallels of 30° and 40° S.

The single species of *Bathyoncus* is from far south.

Polycarpa has two representatives in the northern hemisphere, and three in the southern tropical zone, while the remaining seven species are from the southern temperate regions.

Of the seven genera of the Ascidiidæ, two, *Corella* and *Ciona*, are confined to the northern hemisphere, and three, *Abyssascidia*, *Corynascidia*, and *Pachychlæna*, are purely southern.

Ascidia is only represented by one species in the northern hemisphere, the remaining ten species being confined to southern temperate regions. None of the Challenger Ascidiidæ occur in the tropics.

Hypobythius has one species in the northern hemisphere and one in the southern, both at considerable distances from the equator.

The Clavelinidæ are almost equally represented in the two hemispheres, having two species north of the equator and three to the south. *Clavelina* has one species in each temperate zone, and is not represented at intermediate latitudes. *Ecteinascidia*, finally, has one species (*Ecteinascidia turbinata*) in the northern temperate region, while the remaining two are from the southern tropics.

BATHYMETRICAL DISTRIBUTION.

The remarks made at the commencement of the section upon Geographical Distribution in regard to the uncertainty of the results, on account of the scantiness of our knowledge, apply with equal force to the question of distribution in depth.

The first table given below shows the range in depth of the species, genera, and families of Simple Ascidians. The names are arranged systematically, and the extreme limits of depth at which each species has been found are given.

The depth is not known in the case of *Boltenia pachydermatina*, as the two specimens of that species in the collection were presented to the expedition at Wellington, New Zealand.

Family, Genus, and Species.	Range in Depth.
MOLGULIDÆ—	
Ascopera gigantea,	150 fathoms.
pedunculata,	150 ,,
Molgula gigantea,	55 ,,
gregaria,	5–10 ,,
pedunculata,	150 ,,
horrida,	5–12 ,,
forbesi,	2–10 ,,
pyriformis,	600 ,,
Eugyra kerguelenensis,	10–100 ,,
CYNTHIIDÆ—	
Boltenia elegans,	51 ,,
legumen,	4–15 ,,
pachydermatina,	(?)
Culeolus murrayi,	2300 ,,
wyville-thomsoni,	630 ,,
recumbens,	1375 ,,
perlucidus,	1600 ,,
perlatus,	1700 ,,
moseleyi,	2425 ,,
Fungulus cinereus,	1600 ,,
Microcosmus helleri,	28 ,,
propinquus,	38–40 ,,
polymorphus,	38–40 ,,

Family, Genus, and Species.	Range in Depth.
Cynthia cerebriformis,	6–15 fathoms.
fissa,	38–40 „
formosa,	3–11 „
arenosa,	1–8 „
irregularis,	2–10 „
pallida,	10–20 „
papietensis,	10–20 „
complanata,	6 „
hispida,	38–40 „
Styela bythia,	2600 „
squamosa,	2600 „
grandis,	150 „
gyrosa,	6 „
convexa,	150 „
lactea,	10–100 „
exigua,	2–10 „
clava,	8–50 „
oblonga,	600 „
flava,	600 „
glans,	600 „
radicosa,	38–40 „
Bathyoncus mirabilis,	1600 „
Polycarpa viridis,	2–15 „
tinctor,	2–15 „
minuta,	150 „
molguloides,	38–40 „
quadrata,	129 „
pilella,	7–20 „
rigida,	38–40 „
longisiphonica,	6–15 „
irregularis,	18 „
sulcata,	17 „
pedata,	10–20 „
radicata,	6 and 120 „
ASCIDIIDÆ—	
Corynascidia suhmi,	1375–2160 „
Corella japonica,	8–50 „
Abyssascidia wyvillii,	2600 „
Pachychlæna obesa,	38–40 „
gigantea,	10–20 „
oblonga,	38–40 „
Ascidia challengeri,	10–60 „
vasculosa,	28 „
placenta,	150 „
nigra,	Shallow water, and 150 fathoms.

Family, Genus, and Species.	Range in Depth.
Ascidia meridionalis,	55 and 600 fathoms.
falcigera,	83 „
tenera,	245 and 600 „
translucida,	28 „
cylindracea,	120 „
despecta,	10–100 „
pyriformis,	6 „
Hypobythius calycodes,	2900 „
moseleyi,	600 „
Ciona flemingi,	75 „
savignyi,	8–50 „
CLAVELINIDÆ—	
Ecteinascidia crassa,	129 fathoms.
fusca,	17 „
turbinata,	Shallow water.
Clavelina oblonga,	„ „
enormis,	10–20 fathoms.

From this table it is a simple matter to determine the range in depth of any particular genus, *e.g.*:—

Molgula . extends from 2 to 600 fathoms.
Styela . „ 2 to 2600 „

The four families of Ascidiæ Simplices are found to have the following limits :—

The Molgulidæ range from the shore to 600 fathoms.
The Cynthiidæ „ „ 2600 „
The Ascidiidæ „ „ 2600 „
The Clavelinidæ „ „ 129 „

Hence it appears that there is no family peculiar to deep water, as each of the four has species ranging from a few fathoms of water downwards. The Clavelinidæ have as yet not been found at a depth greater than 129 fathoms, and most of the species inhabit much shallower water. If *Ecteinascidia crassa* be excepted, the Challenger specimens of the Clavelinidæ are all from less than 20 fathoms.

The Molgulidæ are represented in the abyssal zone[1] by *Molgula pyriformis,* at 600 fathoms, while the remaining species range between shallow water and 150 fathoms.

The Cynthiidæ and Ascidiidæ have both a much wider distribution in depth, and each of them contains genera which are peculiarly abyssal. In the Cynthiidæ the sub-

[1] 500 fathoms and upwards.

families Bolteninæ and Styelinæ range into deep water, while the Cynthinæ are all found in less than 40 fathoms. Among the Bolteninæ, *Boltenia* is from shallow water, while *Culeolus* is a peculiarly deep-water genus, but has a considerable range, viz., from 630 to 2425 fathoms. Five of the species are from upwards of 1000 fathoms, four from over 1500, and two from upwards of 2000. Thus they all belong to the abyssal fauna. *Fungulus*, which is closely allied to *Culeolus*, is also a deep-water form.

In the Styelinæ, *Styela* has a range of from shallow water up to 2600 fathoms. Five species belong to the abyssal fauna, three of them being from 600 fathoms, and two from 2600. The remaining species of the genus are all from less than 150 fathoms.

Polycarpa is a shallow-water genus, ranging from quite shallow water to 150 fathoms, and therefore having no representative in the abyssal zone. The remaining genus of the Styelinæ, *Bathyoncus*, is the only peculiarly deep-water genus in the sub-family. It was found at a depth of 1600 fathoms.

In the Ascidiidæ the majority of the species are from small depths, but two genera, *Corynascidia* and *Abyssascidia*, are peculiar to very deep water, while two species of *Ascidia* (*Ascidia meridionalis* and *Ascidia tenera*) also range into the abyssal zone. The remaining species are distributed from shallow water up to 150 fathoms. The species of *Corella*, *Pachychlæna* and *Ciona* are from depths of less than 100 fathoms.

If the range of depth at which Simple Ascidians were found (from the shore down to 2600 fathoms) be divided into five zones, the following results will be arrived at :—

I.—Between the shore and 50 fathoms forty-seven species were found, viz. :—

Molgula gregaria.
horrida.
forbesi.
Eugyra kerguelenensis.
Boltenia legumen.
Microcosmus helleri.
propinquus.
polymorphus.
Cynthia hispida.
cerebriformis.
fissa.
formosa.
arenosa.
irregularis.
complanata,
pallida.
papietensis.

Styela gyrosa.
lactea.
exigua.
clava.
radicosa.
Polycarpa tinctor.
viridis.
longisiphonica.
irregularis.
sulcata.
pilella.
molguloides.
rigida.
pedata.
radicata.
Corella japonica.
Pachychlæna obesa.
gigantea.
oblonga.
Ascidia challengeri.
vasculosa.
nigra.
translucida.
despecta.
pyriformis.
Ciona savignyi.
Ecteinascidia turbinata.
fusca.
Clavelina enormis.
oblonga.

In this list thirteen genera and four families are represented.

II.—Between 50 fathoms and 500 fathoms twenty-two species were found, viz.:—

Ascopera gigantea.
pedunculata.
Molgula gigantea.
pedunculata.
Eugyra kerguelenensis.
Boltenia elegans.

Styela grandis.
lactea.
convexa.
Polycarpa quadrata.
minuta.
radicata.
Ascidia challengeri.
placenta.
nigra.
meridionalis.
falcigera.
tenera.
cylindracea.
despecta.
Ciona flemingi.
Ecteinascidia crassa.

In this list nine genera and four families are represented.

III.—Between 500 fathoms and 1000 fathoms eight species were found, viz.:—

Molgula pyriformis.
Culeolus wyville-thomsoni.
Styela flava.
oblonga.
glans.
Ascidia meridionalis.
tenera.
Hypobythius moseleyi.

In this list five genera and three families are represented.

IV.—Between 1000 fathoms and 2000 fathoms six species were found, viz.:—

Culeolus recumbens.
perlucidus.
perlatus.
Fungulus cinereus.
Bathyoncus mirabilis.
Corynascidia suhmi.

In this list four genera and two families are represented.

V.—Between 2000 fathoms and 3000 fathoms seven species were found, viz.:—

Culeolus murrayi.
moseleyi.
Styela bythia.
squamosa.
Corynascidia suhmi.
Abyssascidia wyvillii.
Hypobythius calycodes.

In this list five genera and two families are represented.

From these lists it appears that Simple Ascidians are much more common in shallow than in deep water, and that comparatively few—twenty species in all—extend into the abyssal zone, while more than twice as many species are found between the shore and 50 fathoms as between 50 fathoms and 500.

These lists, however, do not represent accurately the whole state of affairs, as they do not take into account the greater facilities for collecting in shallow water, nor yet the relative numbers of the deep and the shallow-water dredgings performed during the voyage.

Hence the following list, showing the number of dredgings taken by the expedition in the different zones, and the proportion of them at which Simple Ascidians were found, is necessary, in order to give a complete idea of the bathymetrical distribution :—

In 32	dredgings	at from	0–50	fathoms,	Ascidiæ Simplices	occurred 10	times,[1]	or at 31	per cent. of the Stations.
„ 51	„	50–500	„	„	10	„	20	„	„
„ 23	„	500–1000	„	„	2	„	9	„	„
„ 94	„	1000–2000	„	„	3	„	3	„	„
„ 161	„	2000–3000	„	„	5	„	3	„	„

The column of percentages brings out clearly that although Simple Ascidians extend into very deep water, and are fairly well represented in the abyssal zone, still they are chiefly a shallow-water group, and attain their greatest numerical development immediately around coasts in a few fathoms of water.

It seems impossible to establish any relation between the occurrence of Simple Ascidians and the nature of the bottom. The shallow-water forms appear to affect mud

[1] In addition to this, Simple Ascidians were collected from depths less than 50 fathoms at nine localities which are not given in the list of Stations, viz. :—Bermuda, Bahia, Simon's Bay, Port Jackson, Kandavu, Banda, Hong Kong, Yokohama, and Tahiti.

or sandy mud, but those from deep water are found on various kinds of deposit, including "grey ooze," "globigerina ooze," "red clay," and "hard ground."

Temperature also appears to have little influence upon the distribution of the Ascidiæ Simplices, as the temperatures of their localities range from nearly freezing point upwards.

SUMMARY AND GENERAL REMARKS.

As I intend to reserve the discussion of any questions which affect the Tunicata as a class till the conclusion of the second part of this Report, I have confined myself in the present section to a brief summary of the chief additions made by the Challenger expedition to our knowledge of the Simple Ascidians; to a few remarks upon structural points of novelty or interest, which are not sufficiently brought out in the systematic part; and to a discussion of the phylogenetic relations of the Ascidiæ Simplices, so far as our present knowledge of the group will permit us to make such investigations.

In the following pages the remarks upon the different species are arranged in the order in which the genera occur in the preceding systematic part of the work, beginning with the highest and working downwards.

Among the Molgulidæ the most interesting new forms are the two species of *Ascopera*. Like so many of the species from deep water, they have the posterior end of the body prolonged to form a peduncle by which the animal is attached. In this respect, and in having no hairs upon the test, and no adhering sand grains, they differ from typical Molgulids. These peculiarities are, however, found in one of the species referred to the genus *Molgula*, namely, *Molgula pedunculata*. The two species of *Ascopera* differ in all their internal organs as well as in external appearance. The branchial sacs are very distinct. That of *Ascopera pedunculata* (Pl. II. fig. 5) is regular, and has rather the appearance of the branchial sac of one of the Cynthiidæ, on account of the tendency of the stigmata to lie in transverse rows. In *Ascopera gigantea*, on the other hand, they are always irregularly curved and placed (Pl. II. fig. 1), and consequently the sac in this species has more of the characteristically Molgulid appearance.

Molgula pedunculata shows affinities with *Ascopera*, not only in having a short peduncle, and in the absence of adhering sand, but also in the structure of the branchial sac, which has the stigmata in some places very slightly curved, and arranged in transverse rows very much as in *Ascopera pedunculata* (compare Pl. V. fig. 3, and Pl. II. fig. 5). However, this Cynthiad arrangement is continued for short distances only.

The only other branchial sac among the Molgulidæ which requires special notice is that of *Molgula pyriformis* (Pl. VI. fig. 2). The longitudinal folds are in a rudimentary condition, exactly corresponding to that found in *Styela oblonga* and *Styela glans*, among the Cynthiidæ. The stigmatic portion of the sac does not enter into the folds, which are represented merely by longitudinal tracts, along which the internal

longitudinal bars are more than usually close. In *Molgula pyriformis* there are only three internal longitudinal bars in each of these regions, but, as I have shown elsewhere,[1] in the case of *Styela grossularia*, a more rudimentary condition even may be traced through a series of gentle gradations into a well-developed fold.

The dorsal tubercle is very variable in the Molgulidæ. In typical species of the genus *Molgula* it is usually cordate or reniform in outline, with both horns coiled inwards, but not forming large spirals. In *Molgula forbesi* (Pl. V. fig. 11), we find a comparatively simple tubercle, with one horn turned out and one in, while in *Molgula gigantea*, and in *Ascopera gigantea* (Pl. III. fig. 5), the spirals are very large, quite as large as in any of the Cynthiidæ, which are usually supposed to have the most complicated tubercles. In *Molgula pyriformis* (Pl. VI. fig. 3), and *Eugyra kerguelenensis* (Pl. VI. fig. 9), on the other hand, the dorsal tubercle is found in the simplest possible condition, namely, as the slightly enlarged aperture of the duct from the neural gland bounded by a plain prominent margin, circular in the one case, and quadrangular in the other. It is rather puzzling to find this simple condition of the dorsal tubercle in the most highly differentiated family of Simple Ascidians, and it does not in the least help us towards a solution of the question why in so many other forms the aperture of the duct of a gland should have acquired such a complicated structure. However, the complexity of the dorsal tubercle is evidently not correlated with that of the other organs, as we sometimes find it in very different conditions in two species which, from the rest of their structure, seem closely allied.

Among the Cynthiidæ the sub-family Bolteninæ contains the greatest novelties. It has always been an interesting group, as it contains the rarest and least known forms. The Challenger expedition has revealed the existence of a small group of pedunculated Ascidians, apparently confined to great depths, and having several striking peculiarities. These are more nearly allied to *Boltenia* than to any other previously known genus, and have been placed in two closely related new genera—*Culeolus* and *Fungulus*.

On account of the great interest attaching to these forms, I have gone into very considerable detail in their description, and especially in that of *Culeolus murrayi*, the only large species of which there were two specimens in the collection.

As I have shown in the tables given in the two preceding sections of the Report, both the horizontal and the vertical distributions are wide in this genus. The localities of the species are widely separated, and occupy all the great oceans:—one species being from the North Atlantic, off the east coast of North America; two from the Southern Ocean, between the Cape of Good Hope and Kerguelen Island; one from the South Pacific, to the north of the Kermadec Islands; one from the North Pacific, east of Japan[2]; and one

[1] On Individual Variation in Simple Ascidians, Trans. Lit. and Phil. Soc., Liverpool, 1882.

[2] While these sheets were passing through the press, I received from the Challenger Office a tube containing a small specimen of a *Culeolus* from this locality (Station 241, 2300 fathoms). It is evidently a new species, and will be described and figured in the second part of this Report.

from the centre of the Pacific Ocean, on the equator. It is a curious fact that not more than one of the species was obtained at any single locality. The only two from the same neighbourhood are *Culeolus recumbens* and *Culeolus perlucidus*, which were obtained at consecutive Stations (Nos. 146 and 147) in the Southern Ocean.[1] The first of these stations is the most southern locality for the genus, while Station 44, the locality for *Culeolus perlatus*, is the most northern extension.

Culeolus wyville-thomsoni, which is by far the least deep form of the genus, has a thicker and more ordinary looking test than any of the other species. Otherwise the depth seems to have no effect, the two deepest forms, *Culeolus murrayi* and *Culeolus moseleyi*, having thick, opaque tests, while much the most fragile and transparent form is *Culeolus perlucidus*, from the intermediate depth of 1600 fathoms.

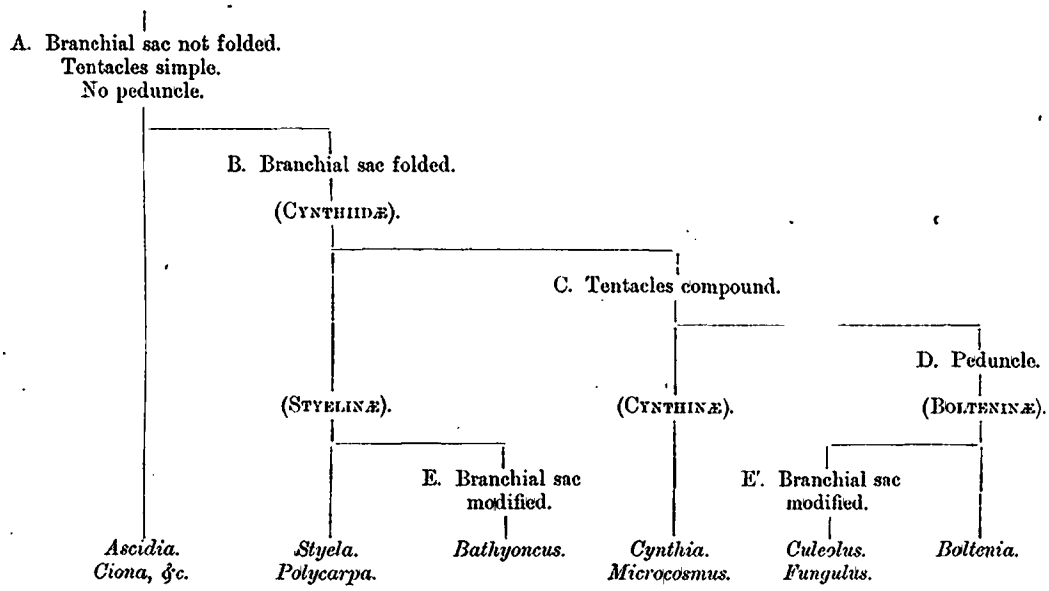
It seems impossible to establish any relation between the nature of the bottom and the occurrence of this genus. Three of the localities are marked globigerina ooze. Two of these, Stations 146 and 147, are very pure and typical examples of this deposit, while the third, Station 271, has a considerable admixture of Radiolarians and Diatoms. Of the three remaining localities, one, Station 241, is a red clay; another, Station 170, is a volcanic deposit, composed of fragments of rock and pumice, with a little mud; while the last, Station 44, is a blue mud, formed of continental débris.

The most important morphological peculiarity is undoubtedly the very remarkable condition of the branchial sac, which is found in all the species of *Culeolus* (*e.g.*, Pl. VIII. fig. 3), in *Fungulus cinereus* (Pl. XIII. fig. 9), and in the curious little species *Bathyoncus mirabilis* (Pl. XXIV. fig. 9.) one of the Styelinæ, but also a deep-water form. It is quite distinct from the branchial sac in any other known Simple Ascidians, and it is interesting to find it present in a member of a different sub-family. This peculiar and simple structure, in which stigmata are apparently not formed, in consequence of the suppression of the fine interstigmatic vessels, at first naturally suggests the simple mesh-work found in *Pyrosoma;* but I am inclined to believe that the true structure of the sac in that genus is a double row of laterally placed stigmata, running transversely in place of longitudinally, and crossed at right angles by the internal longitudinal bars. In this case the branchial sac of *Pyrosoma* shows a simplified state of the condition found in *Boltenia elegans*,[2] where the stigmata are transverse (Pl. VII. fig. 2.), and is entirely different from the branchial sac of *Culeolus*. Consequently, I am not of opinion that the simple form of sac seen in *Culeolus*, *Fungulus* and *Bathyoncus* is a primitive form which has survived, but think, on the contrary, that it is an after modification of a more complicated type, which has probably taken place independently in the Bolteninæ and Styelinæ, and after the separation of these two groups by the development of compound tentacles

[1] And *Culeolus murrayi*, and the new species from Station 241.

[2] I very much doubt even this being the survival of a primitive character, as *Boltenia* is certainly a highly modified form.

in the former. I incline to this view since it permits us to place in close relationship all the pedunculated forms, whether possessing an ordinary or a modified branchial sac, and does not necessitate the independent origin, in two distinct groups, of two sets of very different characters, namely, compound tentacles and a peduncle, but merely of one—the modification of the branchial sac. And this modification has probably taken place after the separation of the Bolteninæ from the Cynthinæ (both these groups have arisen from the Styelinæ previously), because we do not find any traces of the modified branchial sac among the Cynthinæ. The following scheme shows what I imagine to have been the sequence of these stages in the evolution of the Cynthiidæ :—



The whole family seems to have sprung originally from a simple sessile form (marked A. in the scheme), with the branchial sac not folded, and unbranched tentacles, of which the present *Ascidia*, or more probably *Ciona*, is the comparatively little modified descendant. From such a form the ancestral branch of the Cynthiidæ would be first distinguished by a longitudinal folding of the branchial sac, a condition which we find common to the three sub-families. This hypothetical form (B. in the scheme) had still simple tentacles, and is represented at the present day by the Styelinæ. From this line the Cynthinæ and Bolteninæ were later distinguished by the tentacles having become branched in their common ancestor (C. in the scheme), and we find the comparatively slightly modified descendants of this form in the *Cynthia* and *Microcosmus* of the present day. The next stage in differentiation was the formation of a peduncle in the ancestral form of the Bolteninæ (D. in the scheme), represented now by *Boltenia*. Hence the Bolteninæ have been

separated off from the Cynthinæ, since the latter group became distinct from the Styelinæ through the development of compound tentacles. Next comes the modification of the branchial sac, a change consisting in the suppression of the interstigmatic vessels, which appears to have taken place in the Styelinæ and the Bolteninæ independently, and resulting in the evolution of two forms (E. and E′. in the scheme), which were the ancestors of *Bathyoncus* on the one hand and of *Culeolus* and *Fungulus* on the other.

The above is what seems to me the simplest and most natural method of accounting for the structural relations of the present genera, the only difficulty being the independent origin of the modified branchial sac in two distinct groups. And the difficulty is increased, since it is not evident what is the advantage of the structure seen in *Culeolus*, or what is the reason of the modification. The idea that that structure is possibly better suited to certain conditions consequent upon living at great depths is probably not correct, since we find other Simple Ascidians, from as great or greater depths, having the normal structure of branchial sac, such as *Abyssascidia wyvillii*, *Corynascidia suhmi*, *Styela squamosa*, and *Styela bythia*, although it is true these forms are, according to my phylogenetic scheme (page 286), all less highly developed than at least *Culeolus* and *Fungulus*, and probably than *Bathyoncus* also.

A very notable feature in *Culeolus* is the condition of the blood-vessels in the test in some of the species (*e.g.*, *Culeolus murrayi*). This structure, when I first saw it in section (Pl. VIII. fig. 2), at once suggested to my mind the idea that it was an accessory respiratory apparatus, and I still incline to that view. It is not difficult to imagine how the blood-vessels in the test might, especially if the supply was not abundant, become branched in the superficial layers of the organs, and swollen in their end twigs, in order that the blood circulating in the test might thus receive a little additional aeration, and in this way the large blood-vesicles and hollow papillæ of *Culeolus murrayi* could be explained. Possibly the enlarged terminations of the vessels seen in the tests of so many other Ascidians may not only be the same structure in a less developed condition, but may also perform the same function in a slighter degree. A glance at the diagram of the circulation in a Simple Ascidian (page 280), will show that when the heart contracts ventro-dorsally the test receives almost pure blood, but that when, on the other hand, it contracts dorso-ventrally the blood carried to the test is impure blood, which has been returned from the viscera, and is on its way to the branchial sac. From a consideration of this arrangement, it is obvious how advantageous it would be for the Ascidian if the test could act, even to a slight degree, as an accessory respiratory organ, and could allow the blood circulating in its superficial layers to be brought into such close relation with the external medium as to render possible a certain amount of oxydation.

In those forms where the terminal twigs of the blood-vessels are prolonged into delicate processes of the test, these hair-like structures have generally acquired a second function—that of attaching to their surfaces sand grains, small stones, shell fragments, and

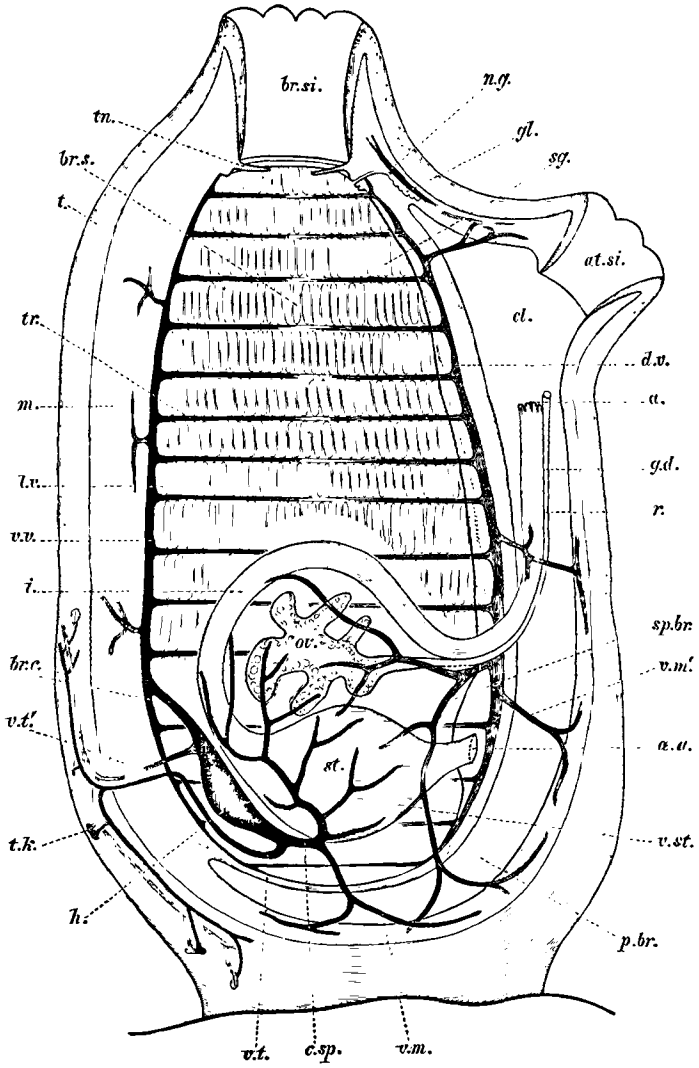


FIG. 23.—Diagrammatic longitudinal section of *Ascidia*, showing the heart, the blood-vessels, the branchial sac, the alimentary canal, &c., from the left side.

br.si., branchial siphon: *at.si.*, atrial siphon; *t.*, test; *m.*, mantle; *br.s.*, branchial sac; *p.br.*, peribranchial cavity; *cl.*, cloaca; *n.g.*, nerve ganglion; *tn.*, tentacle; *gl.*, neural gland; *æ.a.*, œsophageal aperture; *st.*, stomach; *i.*, intestine; *r.*, rectum; *a.*, anus; *ov.*, genital organs; *g.d.*, genital ducts; *h.*, heart; *c.sp.*, cardio-splanchnic vessel; *v.t.*, vessel to the test; *t.k.*, terminal knob on vessel in test; *v.t'.*, vessel from the test; *v.st.*, vessel to the stomach, &c.; *v.m.*, vessel to the mantle; *v.m'.*, vessel from the mantle; *d.v.*, dorsal vessel; *tr.*, transverse vessel of branchial sac; *l.v.*, fine longitudinal vessel of branchial sac; *sg.*, stigmata of branchial sac; *v.v.*, ventral vessel; *br.c.*, branchio-cardiac vessel; *sp.br.*, splanchno-branchial vessel.

other foreign bodies, so as to form a continuous, more or less solid, protecting, and concealing coat. This property is characteristic of the Molgulidæ, but we find it more rarely, though just as well developed, in other families, as, for example, in the case of *Polycarpa molguloides* (Pl. XXII. fig. 5) in the Cynthiidæ, and *Ascidia conchilega* in the Ascidiidæ.

In other cases, again, we find the protective covering of sand adhering directly to the test, no hair-like processes having been developed. Under these circumstances, the coating is usually more or less imperfect, and rarely attains any great thickness; in *Polycarpa tinctor* (Pl. XXI. figs. 1–3), however, there is a complete layer of sand over the outer surface of the test.

Calcareous spicules are present in the internal tissues of two genera of Simple Ascidians, viz., *Culeolus* and *Cynthia*, and in each case they are found in several species of the genus. They are, however, very different in their character in the two genera, being irregularly branched, and with smooth surfaces in *Culeolus* (Plates VIII. to XIII.), while they are simply rod-shaped or fusiform in *Cynthia*, but have their surfaces minutely echinated (Plate XVII.).

In *Culeolus* they are present in all the species except *Culeolus perlucidus*, chiefly in the walls of the endostyle and the branchial sac, but also in the tentacles, the dorsal lamina, and other organs. But though varying in details, such as size, stoutness, number, and length of branches, &c., according to the species and organ, still they have throughout the genus, wherever found, a very great similarity. They have a characteristic appearance which is difficult to describe, but which seems to depend upon their irregular, but rather graceful, mode of branching, their invariably rounded angles and curved ends, and lastly, upon the system of concentric markings, like contour lines, in their interior (Pl. VIII. fig. 6).

In the genus *Cynthia*, on the other hand, the calcareous spicules have a totally different appearance. They have been found in three species, namely, *Cynthia pallida*, Heller, where they were first discovered, *Cynthia complanata*, Herdman, and *Cynthia papietensis*, n. sp., and they occur in the test and the mantle, but especially in the vessels of the branchial sac.

Just as in the case of the spicules of *Culeolus*, so also in *Cynthia*, the spicules, though differing in various details according to the species and the part of the body in which they are found, still have throughout a very characteristic appearance. They are always elongated in shape, sometimes cylindrical, often more or less fusiform, but they are never branched (Pl. XVII. figs. 3, 8, 13, 15, and 19). The outer surface is always ornamented with usually closely-placed transverse rows of very minute spine-like processes, which give a most characteristic appearance to the spicule, and render it very easily recognisable in any tissue (Pl. XVII. figs. 5, 6, and 20).

In all cases, in both *Culeolus* and *Cynthia*, these spicules appear to be formed in the

connective tissue part of the mantle, branchial sac, or other organ, and in one species, *Cynthia complanata*, the spicules of the mantle are enclosed in very distinct membranous sheaths (Pl. XVII. figs. 4, 5, and 6), and curiously enough the sheaths of different spicules are connected by continuations of their ends, so that the different spicules are united to form a system of tube-like structures winding through the tissues of the mantle.

As to the function of these calcareous spicules, I am not prepared to make any definite statement. The first idea which presents itself is naturally that they are for the purpose of giving strength and support to the organs in which they are present; and this is probably the correct explanation in the case of *Culeolus*. In that genus, on account of the large meshes, and the want of fine longitudinal bars, the branchial sac is singularly weak and fragile; and the presence of the large branched spicules in the chief vessels (very frequently placed at their points of intersection, so as to extend into several and strengthen their junction) must materially add to the firmness and solidity of the organ.

This, however, cannot apply in the case of *Cynthia*. There the branchial sac is as strong as in most Simple Ascidians. And the species in which calcareous spicules have been found seem to require support as little as any of the other species of the genus. Besides, the spicules in *Cynthia* are, as has been pointed out above, very different in their characters from those of *Culeolus*, and do not seem as if they would be nearly so suitable for the purpose of strengthening a delicate organ. Consequently, I think it is probable that they have a different function in this genus.

In the Styelinæ, besides a number of new species belonging to the large genera *Styela* and *Polycarpa*, a specimen from deep water was collected, which has necessitated the formation of the new genus *Bathyoncus*. The chief structural peculiarity of this form, namely, its much modified branchial sac, has already been discussed above in connection with *Fungulus* and *Culeolus*.

Besides *Bathyoncus mirabilis*, the only deep-water Styelinæ are two new species of *Styela*—*Styela bythia* and *Styela squamosa*. The former of these has distinct languets (Pl. XVIII. fig. 8) along the free edge of the dorsal lamina—which is usually a plain membrane in the Styelinæ—and the latter has only two well-marked folds upon each side of the branchial sac; but with the exception of these two points, *Styela bythia* and *Styela squamosa* are fairly typical representatives of the otherwise shallow-water genus *Styela*.

In one of the new species of *Polycarpa*, the inconspicuous *Polycarpa minuta*, small rod-shaped calcareous spicules are present, scattered through the prolongation of the connective tissue of the mantle, which forms the covering of the polycarp (Pl. XXII. fig. 4), but they do not seem to be present in any of the other organs of the body.

In the family Ascidiidæ, out of the four new genera formed for Challenger specimens, three, viz., *Hypobythius*, *Corynascidia*, and *Abyssascidia* are somewhat aberrant; while the fourth, *Pachychlæna*, is closely allied to *Ascidia*. *Corynascidia* is undoubtedly

allied to *Corella*, while *Abyssascidia* is a link between *Corynascidia* and *Ascidia*. Like some of the other deep-water forms,—*e.g.*, *Hypobythius*, *Fungulus*, and some of the species of *Culeolus*,—*Corynascidia* has the body pedunculated, and the test is soft and fragile, both in that genus and in *Abyssascidia*. The alimentary canal, also, in all these abyssal forms is small relatively to the size of the branchial sac and of the body generally, while the mantle and branchial sac are always delicate.

The stomach and intestine vary considerably throughout the Ascidiidæ in their relation to the branchial sac, but it is possible to trace the passage of one form into the other. The simplest and central arrangement seems to be that which prevails in the genus *Ciona*, where the œsophagus continues the antero-posterior line of the branchial sac, and thus throws the stomach and the first part of the intestine behind the branchial sac. In *Ascidia* and in *Pachychlæna* a change has been effected, probably by the branchial sac having extended down on the right side of the stomach and intestine, resulting in the arrangement shown in figure 22, page 202.

In *Corella* the relation is very different, and the conditions of affairs found in *Corynascidia* and *Abyssascidia* are intermediate between that seen in *Corella* and the primitive arrangement in *Ciona*. In *Corynascidia* the stomach and intestine, which reach as far back as the posterior end of the branchial sac, but do not extend beyond it, are situated along the dorsal edge of the sac, and, if anything, slightly on the right side (Pl. XXV. fig. 2). This condition might be brought about in a *Ciona*, by making the posterior end of the branchial sac extend down upon the ventral side of the stomach, instead of upon the right side as in *Ascidia*. Then in *Abyssascidia*, where the stomach and intestine are at the posterior end of the right side of the sac (Pl. XXVII. fig. 3), the process commenced in *Corynascidia* has advanced still further, and the branchial sac has extended posteriorly upon the left side, in place of the ventral edge. Finally, in *Corella* (Pl. XXVI. fig. 3) we find the same relation as in *Abyssascidia*, but here the stomach and intestine are still more completely upon the right side of the sac, so as to form a perfect contrast to the arrangement in *Ascidia*; and in this respect *Corella japonica* seems more advanced than *Corella parallelogramma*, where the disposition of the intestine is more like that seen in *Abyssascidia*.

It is more natural, I think, to attribute these changes to a posterior prolongation of the branchial sac, the stomach and intestine remaining comparatively passive, than to suppose that the arrangement found in *Ciona* has become modified into those in *Ascidia* and *Corella*, by the stomach and intestine having moved up in the one case upon the left side of the branchial sac, and in the other upon the right, while in *Corynascidia* they have occupied the dorsal edge.

Ciona shows also the simplest arrangement in the structure of the branchial sac. In most of the species of *Ascidia*, the complication described under the name of longitudinal plication has been produced, while in *Corella* and some other forms the stigmata have

become spirally coiled, and both these changes have been caused by modifications of the fine interstigmatic vessels. The most abnormal form of branchial sac is that found in the genus *Hypobythius*, where there are no internal longitudinal bars. I am inclined to believe this to be a secondary modification, since we occasionally find in species of *Ascidia*, and especially of *Corella* (Pl. XXVI. fig. 8), places where the internal longitudinal bars are irregular and partially absent.

The dorsal lamina is found in several different conditions in the Ascidiidæ. Probably the primitive state was a series of languets, which were outgrowths from the dorsal line of the sac, corresponding to the connecting ducts arising from the transverse vessels. This simple condition is found in *Ciona*, and several other genera, while in *Ascidia* and *Pachychlæna* the languets have become more or less completely united by a membrane, the dorsal lamina proper, but still show traces of their original arrangement by projecting in the form of transverse ribs and marginal teeth. The simpler condition of a series of tapering languets is found constantly amongst the lowest family of Simple Ascidians, the Clavelinidæ, while the more modified and probably much more efficient organ, the plain lamina, prevails in the highest and most complex family, the Molgulidæ. In the intermediate families, the Ascidiidæ and the Cynthiidæ, both conditions and all the transition stages by which the one graduates into the other are found.

Neither of the two previously known genera of the Ascidiidæ in which the test is remarkably modified, namely, *Rhodosoma* and *Chelyosoma*, were collected during the Challenger expedition, but two of the new forms show notable peculiarities in the test, *Pachychlæna* having it greatly thickened all over, while *Hypobythius calycodes*, Moseley, has a series of symmetrically placed nodular, cartilaginous thickenings in the otherwise thin and membranous test.

A few lines will suffice for the family Clavelinidæ, as I shall leave the discussion of reproduction by gemmation for the second part of this Report; and the affinities of the new Challenger genus *Ecteinascidia* have already been fully discussed in the systematic part. In this genus, and still more in *Clavelina*, all the organs are found in a simple condition, not unlike that seen in *Ciona* among the Ascidiidæ. In *Clavelina* internal longitudinal bars are totally wanting, the stomach and intestine extend beyond the branchial sac, and the dorsal lamina is in the form of languets.

Two of the species of *Ecteinascidia* (*Ecteinascidia fusca* and *Ecteinascidia turbinata*) supply us with evidence as to the homology of the languets with the connecting ducts of the branchial sac. In *Ecteinascidia fusca* the connecting ducts are broad and triangular (Pl. XXXVI. fig. 8, *c.d.*), and the languets (Pl. XXXVI. fig. 11, *l.*) are also flattened and triangular, although of course longer, while a short distance at each side of them, just at the right and left edge of the dorsal area of the sac, is a row of processes very similar in every way to the connecting ducts, but having no internal longitudinal bars attached to their apices, which hang freely, like those of the languets (Pl. XXXVI. fig. 11).

Then again, in *Ecteinascidia turbinata*, where the connecting ducts are not expanded and triangular (Pl. XXXVI. fig. 3), the languets are merely finger-like processes (Pl. XXXVI. fig. 6, *l.*), and running down the two sides of the dorsal area are a series of processes, which are shaped exactly like the connecting ducts, but are free at their ends, like the languets beside them (Pl. XXXVI. fig. 6). Hence, it seems to me that there can be little doubt that the languets, and therefore the ribs and teeth of the dorsal lamina, correspond to the connecting ducts of the branchial sac, and not to the papillæ of the internal longitudinal bars.

In conclusion, I give a table (page 286), showing what seem to me to be the genetic relationships between the different groups of the Ascidiæ Simplices. As this is founded merely upon the anatomy of the adult forms, it is of course liable to contain errors of detail, but the main lines are probably correct. The wisdom of attempting to form a genealogical scheme out of such insufficient data, will, I doubt not, be questioned by some, but if of no further value, the table serves at least to show the connection in some of the most important points of structure between the different genera.

The ancestral form of all the Simple Ascidians I imagine to have been something like a *Clavelina* without a peduncle (A. in the table). That is to say, it had a body which was elongated antero-posteriorly, so as to allow the stomach to lie behind the branchial sac; it had unbranched tentacles, and a simple branchial sac, with no folds and no internal longitudinal bars; and finally, it had the power of reproducing by gemmation. From such a form it is easy to derive *Clavelina*, by the change (shown at 1) of the posterior end of the body into a peduncle. Before this took place, however, two series of forms must[1] have split off from the main line: one of these, by a change (2) in the relations of the branchial sac and the stomach, produced the genus *Perophora*, while the other, by the development of internal longitudinal bars in the branchial sac, became a form (B.) which was probably the common ancestor of all the other Simple Ascidians, and which, by the addition of a peduncle (3), attained the structure of *Ecteinascidia*.

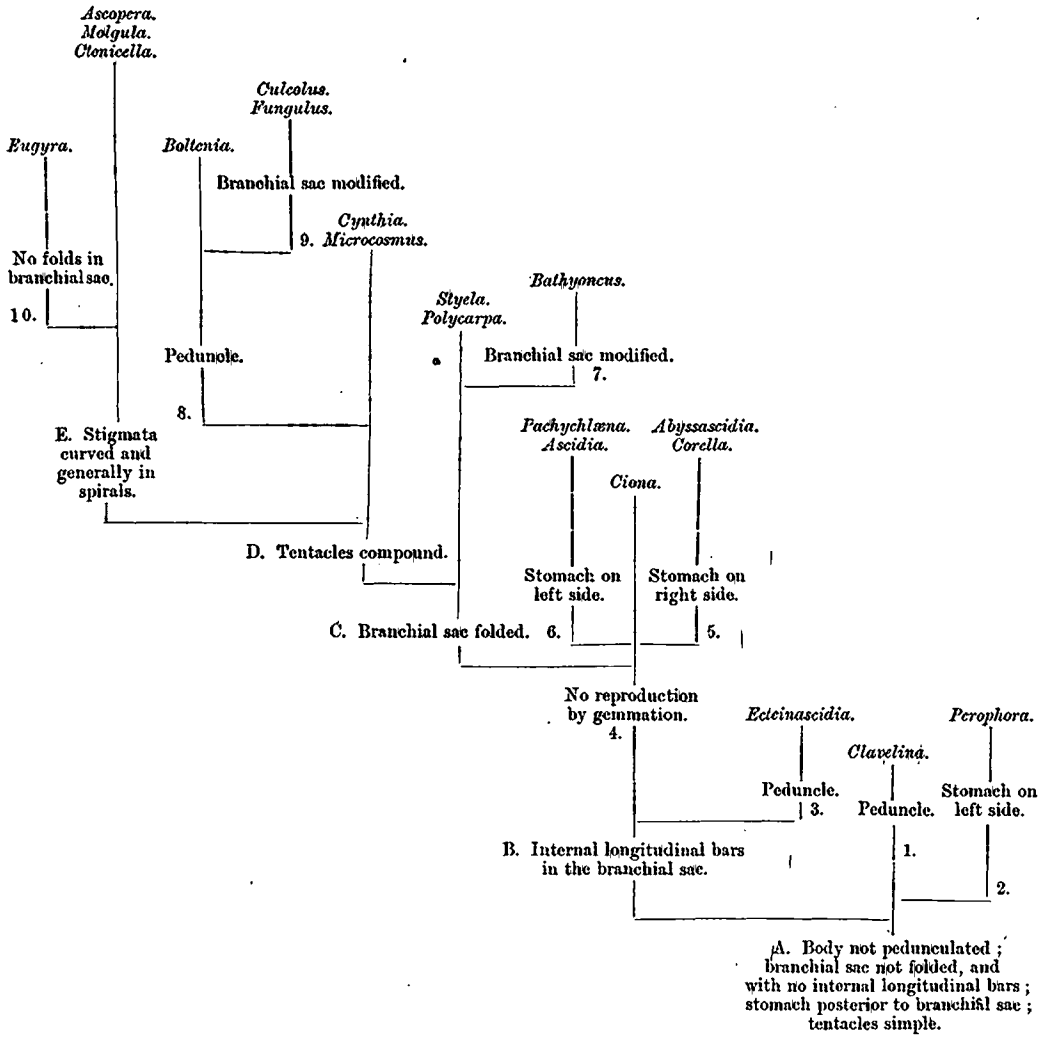
After this point a change must have taken place in the main line, from B. onwards, resulting in the loss of the power of reproducing by gemmation, as this quality is possessed by none of the remaining groups; and thus a form was produced, having all the characters of the genus *Ciona*. This was the common ancestor of the Ascidiidæ, the Cynthiidæ, and the Molgulidæ, and, after the separation of a form (C.) having the branchial sac folded, of the Ascidiidæ alone. From this central *Ciona*-like being, *Abyssascidia* and *Corella* on the one hand, and *Pachychlæna* and *Ascidia* on the other, may be derived, by changing the relations of the stomach to the branchial sac in a manner which has been already described (page 283).

Returning to C., the common ancestor of the Cynthiidæ and Molgulidæ, we find it

[1] This and other objectionably dogmatic words which occur in the following description are merely used to avoid circumlocution. As has been already stated, I fully recognise the hypothetical nature of these investigations.

must have been a form with no peduncle, simple tentacles, internal longitudinal bars and folds in the branchial sac, with the stomach probably posterior, and having no power of gemmation. Such a form is represented, probably with little change, by the genera *Styela* and *Polycarpa*, while *Bathyoncus* has diverged at the point 7. *Pelonaia*, which like *Bathyoncus* differs from the other Styelinæ in having the branchial sac modified, is probably of comparatively recent formation, as some of the species of *Styela* show tendencies in the same direction,—*i.e.*, towards the loss of the branchial folds. From the main stem between C. and *Styela*, a form D. has branched off, which had compound tentacles, and was the common ancestor of the Cynthinæ, the Bolteninæ, and the Molgulidæ.

PHYLOGENETIC TABLE OF THE ASCIDIÆ SIMPLICES.



A, B, C, D, and E are hypothetical ancestral forms of large groups, while 1–10 are points where a change of structure is supposed to have taken place, resulting in the divergence of one or more genera from the main line.

The direct descendants of such a form are probably the genera *Cynthia* and *Microcosmus*, while from this stem two side branches have arisen, one (E.) resulting in the ancestors of the family of the Molgulidæ, and the other by the development of a peduncle (8), leading to the Bolteninæ, and especially to the genus *Boltenia*—*Culeolus* and *Fungulus* being comparatively recent modifications (9).

E. is a modified Cynthiad form, in which the interstigmatic vessels have become curved and probably spirally coiled, so that the branchial sac has the structure found in the typical Molgulidæ. The genus *Eugyra* has probably been formed by the divergence from the main line, between E. and *Molgula*, of a form (10) in which the folds in the branchial sac had become rudimentary.

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Peripharyngeal band, 32, 36.
Péron, 6.
Perophora, 46, 49, 175, 238, 239, 246.
listeri, 7.
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mammillata, Cuv., 8.
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Pituitary body, 43.
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irregularis, Herdm., **178**, 253, 258 (Pl. xxiii. figs. 7, 8).
longisiphonica, Herdm., **177**, 252, 257 (Pl. xxiii. figs. 3–6).
minuta, Herdm., **171**, 251, 256 (Pl. xxii. figs. 1–4).
molguloides, Herdm., 58, 167, **172**, 251, 256, 281 (Pl. xxii. 5–7).
pedata, Herdm., **180**, 182, 253, 258 (Pl. xxiv. figs. 1, 2).
pedunculata, Heller, 182.
pilella, Herdm., **174**, 250 (Pl. xxii. figs. 11–15).
quadrata, Herdm., 168, **173**, 253, 257 (Pl. xxii. figs. 8–10).
radicata, Herdm., 167, **181**, 252, 257 (Pl. xxiv. figs. 3–5).
rigida, Herdm., **175**, 177, 251, 256 (Pl. xxiii. figs. 1, 2).
sulcata, Herdm., 167, 168, **179**, 253, 258 (Pl. xxiii. figs. 9–13).
tinctor, Q. and G., 167, 168, **170**, 252, 257, 281 (Pl. xxi. figs. 1–6).
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viridis, Herdm., 30, 167, **168**, 252, 257 (Pl. xxi. figs. 7–14).
Polyclinidæ, 25.
Position, 26.
Præbranchial zone, 32.
Pyrosoma, 6, 7, 28, 31, 36, 39, 43, 48, 49, 51, 55, 277.
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Salpidæ, 25.
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Schalk, 6.
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Schmidt, C., 7.
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Sphincter, 30, 32.
Spicules, 29, 98, 143, 146, 281, 282.
Stigmata, 32.
Stimpson, 8.
Stolon, 28.
Styela, Han., 149, 150, 167.
Styela, Macl., 7, 38, 54, 60, 83, 135, 138, 148, **149**, 162, 166, 167, 168, 269, 270.
bythia, Herdm., **151**, 153, 162, 251, 256, 265, 279, 282 (Pl. xviii. figs. 1 and 6–8).
clava, Herdm., **158**, 253, 258, 265 (Pl. xix. figs. 9, 10).
convexa, Herdm., **155**, 251, 256 (Pl. xix. figs. 3, 4).
exigua, Herdm., **157**, 252, 257 (Pl. xix. figs. 5, 6).
flava, Herdm., 84, 151, 152, **160**, 172, 174, 254, 259 (Pl. xx. figs. 1–6).
glans, Herdm., **162**, 174, 254, 259, 275 (Pl. xx. figs. 10–13).
grandis, Herdm., **153**, 251, 256 (Pl. xix. figs. 1, 2).
grossularia, van Ben., 34, 45, 84, 150, 171, 276.
gyrosa, Heller, 151, **155**, 252, 257.
lactea, Herdm., **156**, 251, 256 (Pl. xix. figs. 7, 8).
oblonga, Herdm., 84, 151, **159**, 172, 174, 254, 259, 275 (Pl. xx. figs. 7–9).
radicosa, n. sp., **163**, 251, 256 (Pl. xxiv. figs. 6, 7).
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Suhm, R. von Willemœs, 117.
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Test, 28, 30, 31.
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Thaliacea, 1, 25, 41, 48.
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Vascular system, 50.
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EXPLANATION OF THE PLATES.

I am indebted to Professor Moseley for the drawings of *Hypobythius calycodes*, from which figures 1, 2 and 5 on Plate XXXVII. have been prepared. Figure 1 on Plate XVIII. is taken from a careful drawing executed for Mr. Murray by Mr. George West.

With the exception of these four, all the figures have been lithographed by Mr. Frederick Huth, jun., from my own drawings, supplemented, in the case of a few of the views of the external appearance, by the actual specimen represented.

It may be well to mention that some of the branchial sacs represented are "combination figures," formed of small portions from several different specimens pieced together. It was necessary to adopt this plan, in order to show the various important points of structure within the compass of a reasonably small figure.

With the exception of a few which are only slightly enlarged, all the magnified figures were drawn as seen by one of the following combinations, and are marked in the explanations with the number of the objective used :—

Hartnack, obj. 4, with medium ocular	= × 50
Hartnack, obj. 5, ,, ,,	= × 180
Hartnack, obj. 7, ,, ,,	= × 330
Hartnack, obj. 10 (water immersion),	= × 750
Zeiss, obj. $\frac{1}{12}$ (oil immersion), with ocular 4	= × 950

LIST OF ABBREVIATIONS.

a. . . the anus.
at. . . the atrial aperture.
at.n. . . the nerves arising from the atrial end of the ganglion.
at.t. . . atrial tentacles.
b.c. . . the blood corpuscles.
bl. . . the bladder cells in the test.
br. . . the branchial aperture.
br.f. . . the longitudinal folds in the branchial sac.
br.n. . . the nerves arising from the branchial end of the ganglion.
cap. . . the capillaries.
c.b.a. . . the central brown area in the endostyle.
c.d. . . the connecting duct in the branchial sac.
d.l. . . the dorsal lamina.
d.t. . . the dorsal tubercle.
e.l. . . the external longitudinal vessels in the branchial sac.
en. . . the endostyle.
f. . . fibres in the test.
g. . . the hermaphrodite genital mass.

g.d. . . the genital ducts.
gl.n. . . the subneural gland.
g.s. . . the germinal spot in the ovum.
g.v. . . the germinal vesicle in the ovum.
h. . . the heart.
h.t. . . the hepatic tubules.
h.m. . . the horizontal membranes in the branchial sac.
i. . . the intestine.
i.c. . . the intestinal cæcum.
i.l. . . the internal longitudinal bars in the branchial sac.
i.v. . . blood-vessel to the intestine.
l. . . the languets.
l'. . . smaller languets.
l.b.b. . . the lateral brown bands in the endostyle.
l.v. . . the fine longitudinal (or interstigmatic) vessels in the branchial sac.
m. . . the mantle.
m.b. . . the muscular bands in the mantle.
m.f. . . the muscular fibres in the branchial sac.
mh. . . the meshes in the branchial sac.
mh.n. . . a narrow mesh in the branchial sac.
mh.w. . . a wide mesh in the branchial sac.
n. . . the neural mass.
n.g. . . the nerve ganglion.
o. . . a mature ovum.
o'. . . a young ovum.
o.d. . . the oviduct.
œ. . . the œsophagus.
œ.a. . . the œsophageal aperture.
o.m. . . the oblique membranes in the branchial sac.
v. . . the ovary.
p. . . the papillæ on the internal longitudinal bars of the branchial sac.
p'. . . the small intermediate papillæ.
p.c. . . a pigment corpuscle.
ped. . . the peduncle.
ped.c. . . the cavity in the peduncle.
ped.v. . . the blood-vessels in the peduncle.
p.p. . . the peripharyngeal bands.
r. . . the rectum.
r.o. . . the renal organ.
r.v. . . the radiating vessels (angular) in the branchial sac.
r'.v'. . . the radiating vessels (interangular) in the branchial sac.
s. . . suspensor or connective between branchial sac and mantle.
sg. . . the stigmata in the branchial sac.
sg.c. . . the stigmatic or ciliated cells in the branchial sac.
sp. . . the spicules.
st. . . the stomach.
s.v. . . the spiral vessels in the branchial sac.
t. . . the test.
t.a. . . the translucent area in the endostyle.
t.c. . . the small cells in the test.
t.e. . . the terminal enlargement of a blood-vessel in the test.
t.k. . . the terminal knob on vessels in the test.
t.k'. . . a modification of *t.k.*
t.k.c. . . cornified papilla on the test.
t.m. . . the matrix of the test.
t.m.c. . . a part of the test cornified.
tn. . . a tentacle.
tn'., *tn''.* . smaller tentacles.
tn.m. . . the membrane on the branchial side of the tentacle.
t.p. . . a papilla on the outer surface of the test.
tr. . . the transverse vessels in the branchial sac.
tr'., *tr''.* . smaller transverse vessels in the branchial sac.
trab. . . the brown trabeculæ in the peduncle.
tr.x. . . extra wide transverse vessel in the branchial sac.
t.t. . . a thickening of the test.
t'.t'. . . the same for the support of the viscera.
t.v. . . a testicular vesicle.
v. . . a blood-vessel in the test.
v.d. . . the vas deferens.
w.e. . . the white (or clear) edge of the endostyle.
w.l. . . the wide longitudinal vessel in the branchial sac.
z. . . the præbranchial zone.

PLATE I.

PLATE I.

Ascopera gigantea, Herdman.

Fig. 1. *Ascopera gigantea*, from the left side; three-fourths of the natural size.

Fig. 2. The neighbourhood of the œsophageal aperture, seen from the interior of the branchial sac, showing the aperture, the posterior end of the dorsal lamina, and the œsophageal extremities of the fourteen branchial folds; natural size.

Fig. 3. Dissection to show the course of the alimentary canal, seen from the right side, and exposed by the removal of the mantle and the branchial sac, showing the œsophagus, stomach, intestine, rectum, genital gland, and part of the musculature of the left side of the mantle; natural size.

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ASCOPERA GIGANTEA, Herdman.

PLATE II.

PLATE II.

Figs. 1–4. *Ascopera gigantea*, Herdman.
Fig. 5. *Ascopera pedunculata*, Herdman.

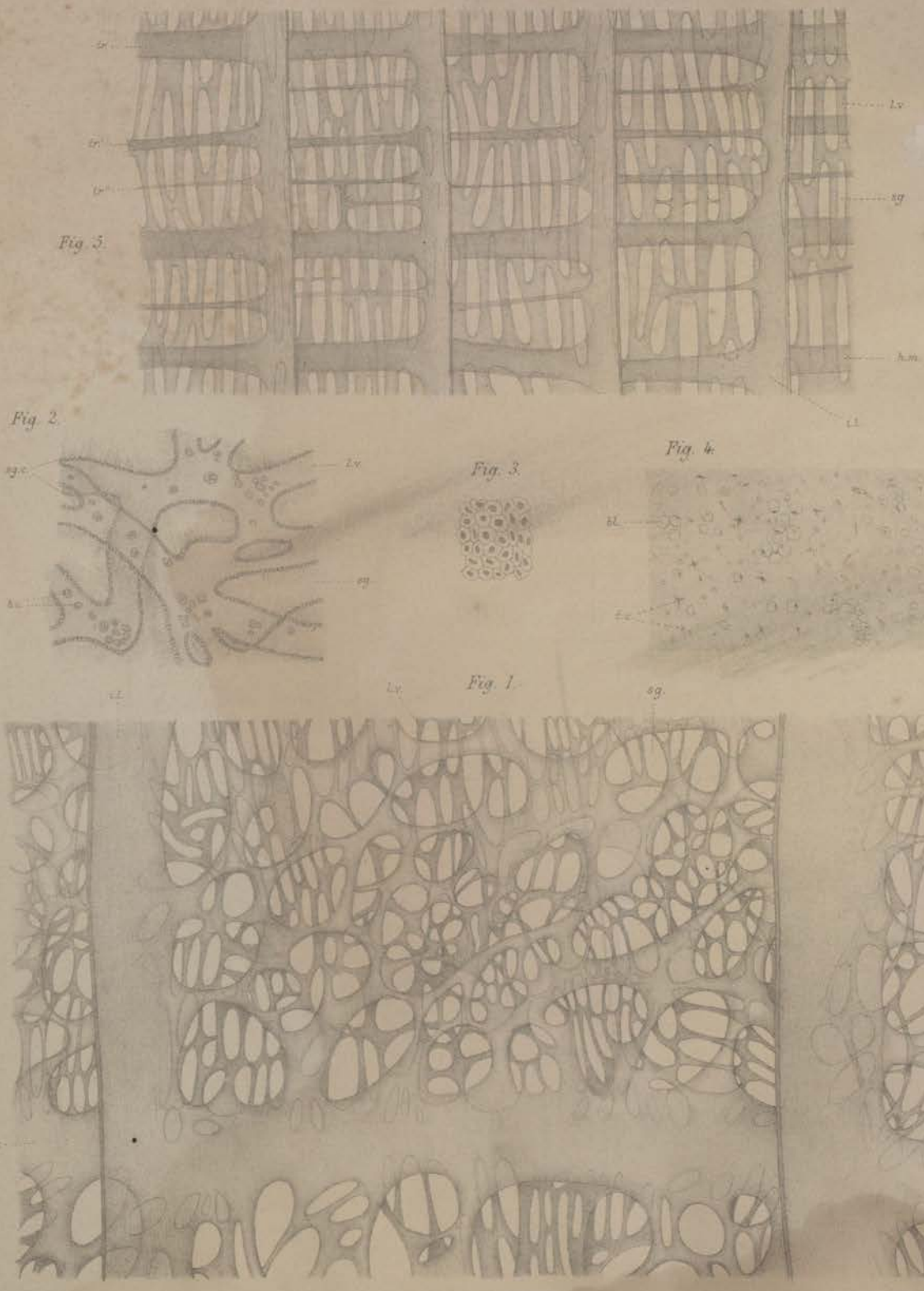
Fig. 1. Part of the branchial sac of *Ascopera gigantea*, between two folds, seen from the inner side, magnified, showing a transverse vessel (*tr.*), two internal longitudinal bars (*i.l.*), and the stigmatic network between (Hartn., obj. 4).

Fig. 2. A small portion of the last figure, greatly magnified, to show the ciliated cells (*sg. c.*) lining the stigmata (Hartn., obj. 7).

Fig. 3. Squamous epithelial cells from the surface of a transverse vessel; much magnified (Hartn., obj. 10).

Fig. 4. Part of a section through the test of *Ascopera gigantea*, showing the stellate cells and small bladder cells; magnified (Hartn., obj. 5).

Fig. 5. Part of the branchial sac of *Ascopera pedunculata*, seen from the inside; magnified (Hartn., obj. 6).



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FIGS. 1-4 ASCOPERA GIGANTEA, Herdman. FIG. 5 ASCOPERA PEDUNCULATA, Herdman.

PLATE III.

PLATE III.

Figs. 1 and 2. *Ascopera pedunculata*, Herdman.
Figs. 3–5. *Ascopera gigantea*, Herdman.

Fig. 1. *Ascopera pedunculata*, from the left side; three-fourths of the natural size.

Fig. 2. The dorsal tubercle of *Ascopera pedunculata*; enlarged.

Fig. 3. Part of the branchial sac of *Ascopera gigantea*, seen from the interior; enlarged, showing a branchial fold (*br.f.*) and part of the intermediate area (*mh.*).

Fig. 4. Part of the branchial sac of *Ascopera gigantea*, between two internal longitudinal bars, to show an unusually simple and regular arrangement of the stigmata; magnified (Hartn., obj. 4).

Fig. 5. The dorsal region of the anterior end of the branchial sac of *Ascopera gigantea*, showing the dorsal tubercle, part of the tentacular circlet, the branchial folds, dorsal lamina, &c; natural size.

Fig. 1.

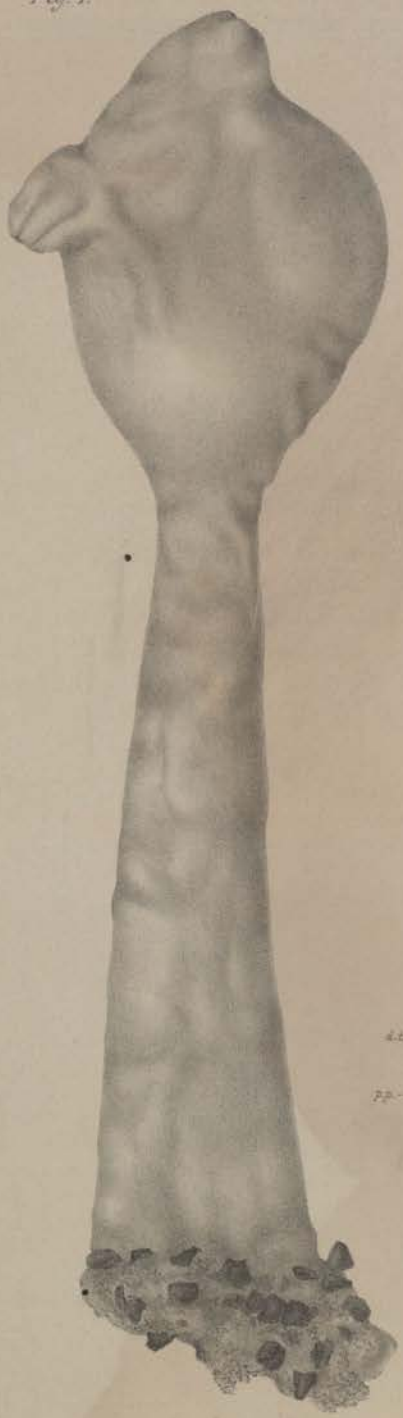


Fig. 2.

Fig. 3.

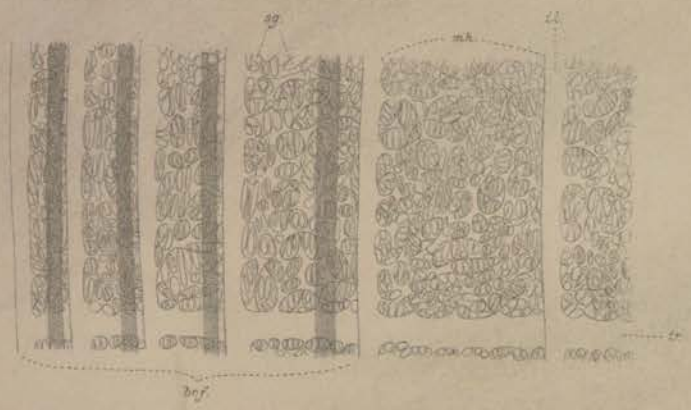
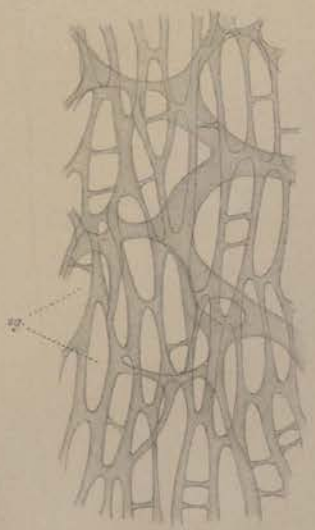


Fig. 5.

Fig. 4.



W. A. Herdman del.

F. Huth, Lith. Edinr.

FIGS 1-2 ASCOPERA PEDUNCULATA, Herdman. FIGS 3-5 ASCOPERA GIGANTEA, Herdman.

PLATE IV.

PLATE IV.

Figs. 1–4. *Molgula gigantea*, Cunningham.
Figs. 5–8. *Molgula gregaria*, Lesson.

Fig. 1. *Molgula gigantea*, a small specimen, from the left side; natural size.

Fig. 2. Part of the branchial sac of *Molgula gigantea*, from the inside, natural size, to show the longitudinal folds (*br.f.*), and the distant transverse vessels (*tr.*).

Fig. 3. Part of the preceding figure, between two folds, greatly enlarged, to show the infundibula and the stigmata (Hartn., obj. 4).

Fig. 4. Dorsal part of the branchial sac of *Molgula gigantea*, from the inside, natural size, showing the dorsal tubercle, the peripharyngeal bands, part of the tentacular circlet, the dorsal lamina, the œsophageal aperture, and part of the branchial sac.

Fig. 5. *Molgula gregaria*, a large specimen, from the dorsal edge of the right side: natural size.

Fig. 6. Part of the branchial sac of *Molgula gregaria*, from the inside; magnified (Hartn., obj. 4).

Fig. 7. Dissection of the viscera on the right side of the mantle in *Molgula gregaria*, from the inside, showing the genital gland (*g.*), and the renal organ (*r.o.*); natural size.

Fig. 8. Part of a section through the test of *Molgula gregaria*, showing the large stellate protoplasts (*t.c.*), in some of which clear vacuoles have appeared: magnified (Hartn., obj. 7).

Fig. 2.

Fig. 1.

Fig. 4.

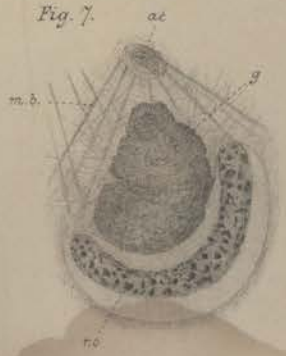
Fig. 3.

Fig. 6.

Fig. 5.

Fig. 8.

Fig. 7.



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FIGS. 1-4 MOLGULA GIGANTEA, Cunningham. FIGS. 5-8 MOLGULA GREGARIA, Lesson.

PLATE V.

PLATE V.

Figs. 1–3. *Molgula pedunculata*, Herdman.
Figs. 4–7. *Molgula horrida*, Herdman.
Figs. 8–11. *Molgula forbesi*, Herdman.

Fig. 1. *Molgula pedunculata*, from the left side and anterior end ; natural size.

Fig. 2. The same with the test removed, showing the siphons, the musculature of the mantle, and the position of the nerve ganglion ; natural size.

Fig. 3. Part of the branchial sac of *Molgula pedunculata*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 4. *Molgula horrida*, from the right side ; natural size.

Fig. 5. The same with the test removed, to show the funnel-like siphons, the musculature of the mantle, and the position of the renal organ on the right side ; natural size.

Fig. 6. The dorsal tubercle, and part of the tentacular circlet of *Molgula horrida*, seen from the inside ; enlarged.

Fig. 7. Part of the branchial sac of *Molgula horrida*, seen from the inside ; magnified (Hartn., obj. 4)

Fig. 8. *Molgula forbesi*, from the right side ; natural size.

Fig. 9. The same with the test removed, seen from the left side, showing the position of the alimentary canal and the genital gland ; natural size.

Fig. 10. Part of the branchial sac of *Molgula forbesi*, seen from the inside ; magnified (Hartn., obj. 4).

Fig 11. The dorsal tubercle and the peritubercular area of *Molgula forbesi ;* magnified (Hartn., obj. 4).

Fig. 1.

Fig. 3.

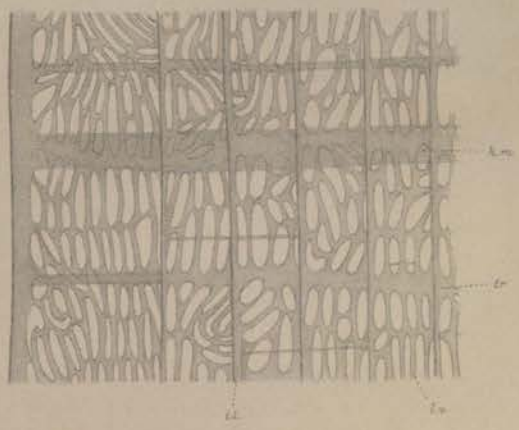


Fig. 2.

Fig. 5.

Fig. 4.

Fig. 11.

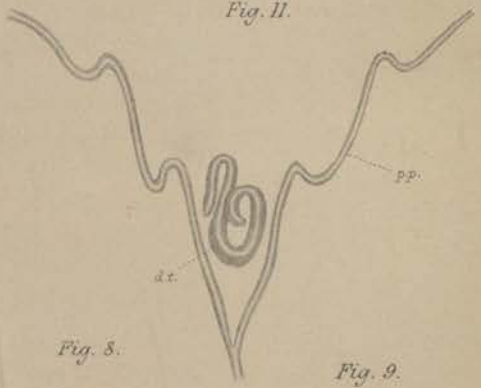


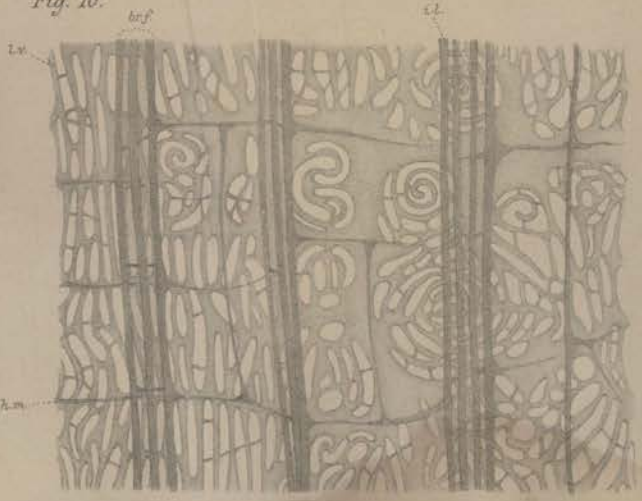
Fig. 6.

Fig. 8.

Fig. 9.

Fig. 7.

Fig. 10.



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FIGS 1-3 MOLGULA PEDUNCULATA, Herdman. FIGS 4-7 MOLGULA HORRIDA, Herdman.
FIGS 8-11 MOLGULA FORBESI, Herdman.

PLATE VI.

PLATE VI.

Figs. 1–3. *Molgula pyriformis*, Herdman.
Figs. 4–9. *Eugyra kerguelenensis*, Herdman.

Fig. 1. *Molgula pyriformis*, from the left side ; natural size.

Fig. 2. Part of the branchial sac, seen from the inside, showing two of the branchial folds, and an interspace ; magnified (Hartn., obj. 4).

Fig. 3. The peritubercular area and dorsal tubercle ; magnified (Hartn., obj. 4).

Fig. 4. *Eugyra kerguelenensis*, from the right side ; natural size.

Fig. 5. Another specimen of the same species, from the right side ; natural size.

Fig. 6. Part of the tentacular circlet, magnified, showing the different orders of tentacles (Hartn., obj. 4).

Fig. 7. Portion of one of the branched tentacles, to show the loose membrane (*tn.m.*) upon the posterior surface ; much magnified (Hartn., obj. 5).

Fig. 8. Part of the branchial sac of *Eugyra kerguelenensis*, from the inside, showing a complete mesh and an infundibulum ; magnified (Hartn., obj. 4).

Fig. 9. The peritubercular area and dorsal tubercle of *Eugyra kerguelenensis*, showing the simple quadrangular aperture of the duct, from the inside ; magnified (Hartn., obj. 4).

Fig. 1.

Fig. 2.

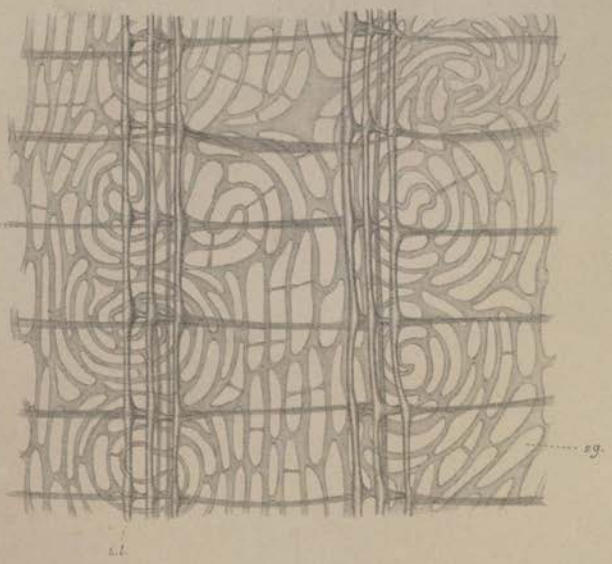


Fig. 3.

Fig. 4

Fig. 6.

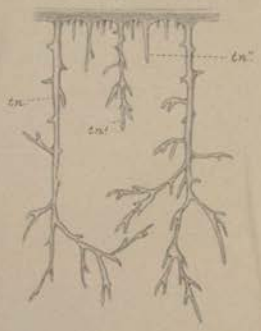


Fig. 5.

Fig. 7.

Fig. 8.

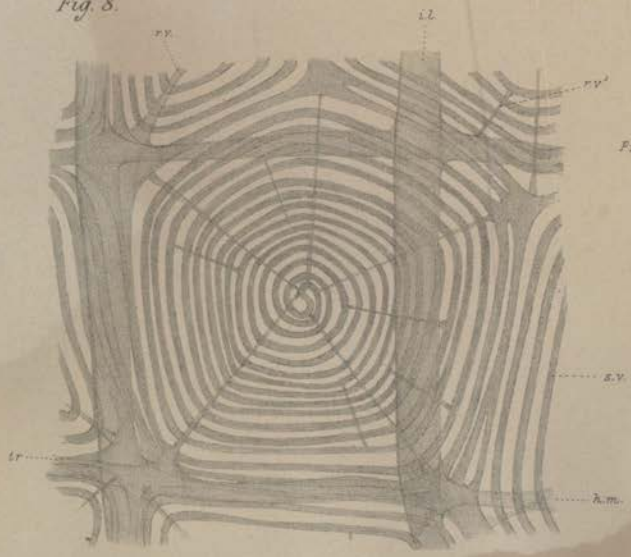
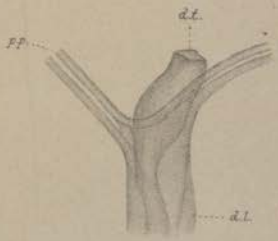


Fig. 9.



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FIGS. 1-3 MOLGULA PYRIFORMIS, Herdman. FIGS. 4-9 EUGYRA KERGUELENENSIS, Herdman.

PLATE VII.

PLATE VII.

Figs. 1-5. *Boltenia elegans*, Herdman.
Figs. 6-8. *Boltenia pachydermatina*, Herdman.

Fig. 1. *Boltenia elegans*, from the right side ; natural size.

Fig. 2. Part of the branchial sac of the same species, from the inside, showing parts of two folds (*br.f.*), and the transversely placed stigmata in the interspace (Hartn., obj. 4.)

Fig. 3. The peritubercular area and dorsal tubercle, from the inside ; natural size.

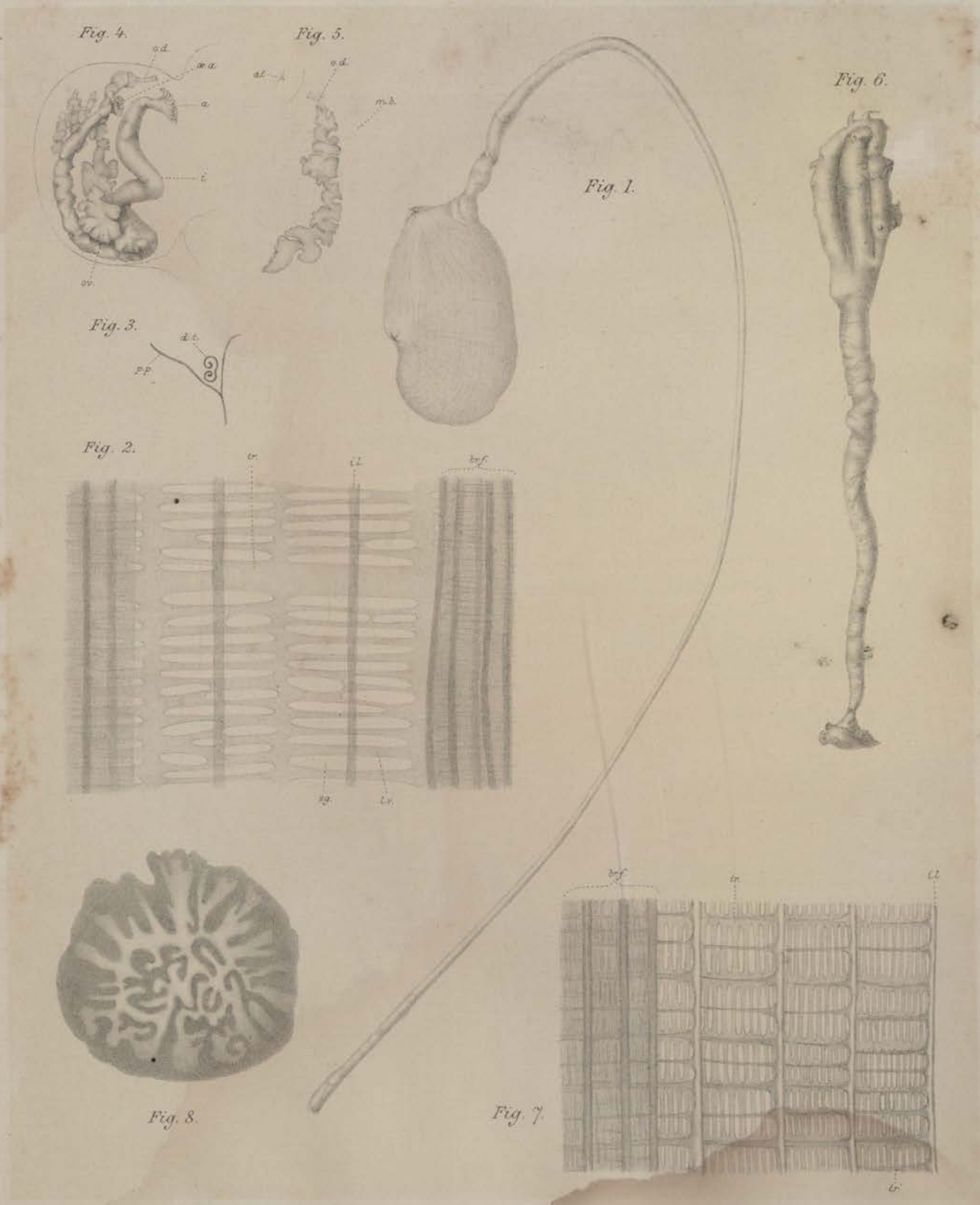
Fig. 4. Dissection of the left side of the body, to show the alimentary canal and genital organs, from the right side ; natural size.

Fig. 5. The right side of the mantle, from the inside, showing the genital gland, and the network of muscle bands ; natural size.

Fig. 6. *Boltenia pachydermatina*, a small specimen, from the right side ; natural size.

Fig. 7. Part of the branchial sac, from the inside ; magnified (Hartn., obj. 4).

Fig. 8. The surface of the dorsal tubercle ; much enlarged.



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FIGS 1-5 BOLTENIA ELEGANS, Herdman FIGS 6-8 B. PACHYDERMATINA, Herdman.

PLATE VIII.

PLATE VIII

Culeolus murrayi, Herdman.

Fig. 1. *Culeolus murrayi*, from the left side ; natural size.

Fig. 2. A section through the outer part of the test, to show the blood-vessels (*v.*), papillæ (*t.p.*), and enlarged knobs (*t.k.'*) ; magnified (Hartn., obj. 4).

Fig. 3. Part of the branchial sac, from the inside, showing one of the branchial folds (*br.f.*) ; magnified (Hartn., obj. 4).

Fig. 4. Part of the endostyle, with the edges laid out flat ; slightly enlarged.

Fig. 5. Part of the endostyle, seen from the inside, showing the clear edges, the spicules, and the central brown bands ; magnified (Hartn., obj. 4).

Fig. 6. A portion of one of the large branched spicules from the branchial sac, to show the concentric lines ; greatly magnified (Hartn., obj. 10).

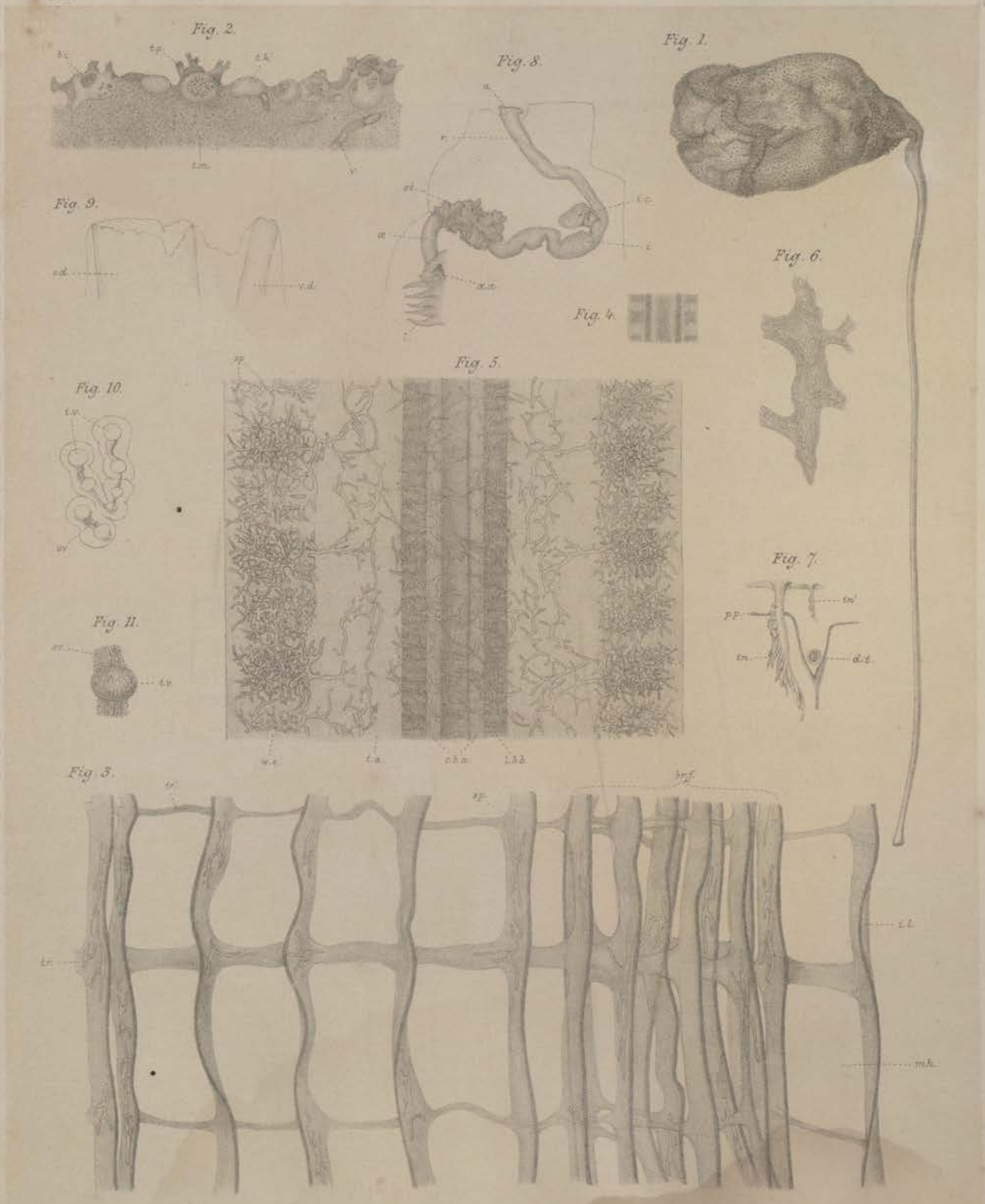
Fig. 7. The dorsal part of the anterior end of the branchial sac, seen from the inside, showing a large (*tn.*) and a small (*tn.'*) tentacle, the peritubercular area, the dorsal tubercle, the præbranchial zone, &c. ; slightly enlarged.

Fig. 8. Dissection, showing the alimentary canal from the œsophageal aperture (*œ.a.*) onwards ; slightly enlarged.

Fig. 9. The terminations of the genital ducts ; magnified (Hartn., obj. 4).

Fig. 10. The genital glands of the right side ; natural size.

Fig. 11. Part of the last figure, more enlarged, showing the testis and the surrounding ova.



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CULEOLUS MURRAYI, Herdman.

PLATE IX.

PLATE IX.

Culeolus murrayi, Herdman.

Fig. 1. A transverse section through the peduncle of *Culeolus murrayi;* magnified (Hartn., obj. 4).

Fig. 2. Part of a longitudinal section through the same peduncle; magnified (Hartn., obj. 4).

Fig. 3. One of the hollow papillæ from the outer surface of the test; magnified (Hartn., obj. 4).

Fig. 4. Blood corpuscles from the interior of a papilla; much magnified (Hartn., obj. 7).

Fig. 5. Part of an internal longitudinal bar from the branchial sac; much magnified (Hartn., obj. 5).

Fig. 6. A small portion of the last figure more magnified (Hartn., obj. 7).

Fig. 7. Calcareous spicules from the thin layer of mantle covering the viscera on the left side; magnified (Hartn., obj. 4).

Fig. 8. Part of the same layer of mantle, more magnified, to show the epithelium (Hartn., obj. 7).

Fig. 9. The wall of the heart; much magnified (Hartn., obj. 7).

Fig. 10. A few of the fusiform muscle-cells from the last figure; more enlarged (Hartn., obj. 10).

Fig. 11. Part of the pericardial membrane, showing a spicule (*sp.*), and the polygonal epithelium; much magnified (Hartn., obj. 7).

Fig. 12. One of the smaller tentacles, showing spicules, blood corpuscles, &c.; magnified (Hartn., obj. 4).

Fig. 13. Details of structure of a tentacle—

a. The tip of a tentacle; much enlarged (Hartn., obj. 5).

b. and c. Parts of the epithelium of the surface of a tentacle; much enlarged (Hartn., obj. 7).

d. Surface view of the short columnar cells of the free (anterior) edge; much magnified (Hartn., obj. 7).

e. The same cells; profile view.

Fig. 14. Part of the dorsal lamina, showing the languets; enlarged.

Fig. 15. The neighbourhood of the nerve ganglion, showing also the dorsal tubercle (*d.t.*); slightly enlarged.

Fig. 16. The structure of the ova; magnified.

a. A mature ovum, showing the germinal vesicle (*g.v.*), and germinal spot (*g.s.*) (Hartn., obj. 7).

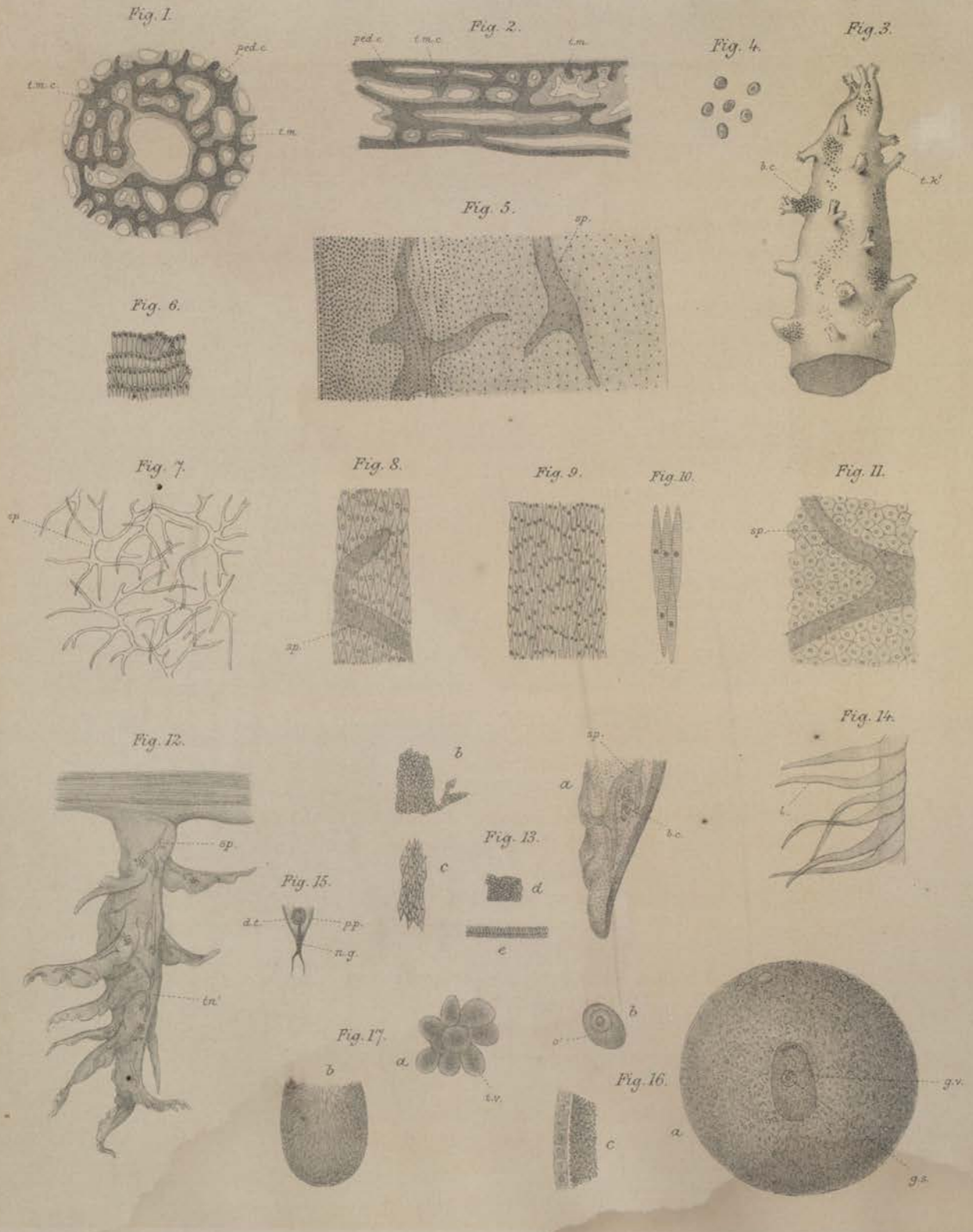
b. A young ovum, with comparatively little vitellus around the germinal vesicle (Hartn, obj. 7).

c. The outer edge of the mature ovum, more enlarged, showing the capsule of cubical epithelium (Hartn., obj. 7).

Fig. 17. The structure of the testis—

a. Clump of spermatic vesicles; magnified (Hartn., obj. 4).

b. The end of a vesicle; more enlarged (Hartn., obj. 7).



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CULEOLUS MURRAYI, Herdman.

PLATE X.

PLATE X.

Figs. 1–6. *Culeolus wyville-thomsoni*, Herdman.
Figs. 7–12. *Culeolus moseleyi*, Herdman.

Fig. 1. *Culeolus wyville-thomsoni*, from the left side ; natural size.

Fig. 2. The branchial aperture ; natural size.

Fig. 3. The atrial aperture ; natural size.

Fig. 4. A section through the test, to show the modifications of the blood-vessels ; magnified (Hartn., obj. 4).

Fig. 5. Part of the branchial sac, from the inside, showing one of the branchial folds (*br.f.*) ; magnified (Hartn., obj. 4).

Fig. 6. The dorsal region of the anterior end of the branchial sac, showing the inside of the branchial siphon, the tentacles, the præbranchial zone, the peri-pharyngeal band, the peritubercular area, the dorsal tubercle, the languets, and part of the branchial sac ; slightly enlarged.

Fig. 7. *Culeolus moseleyi*, from the right side ; natural size.

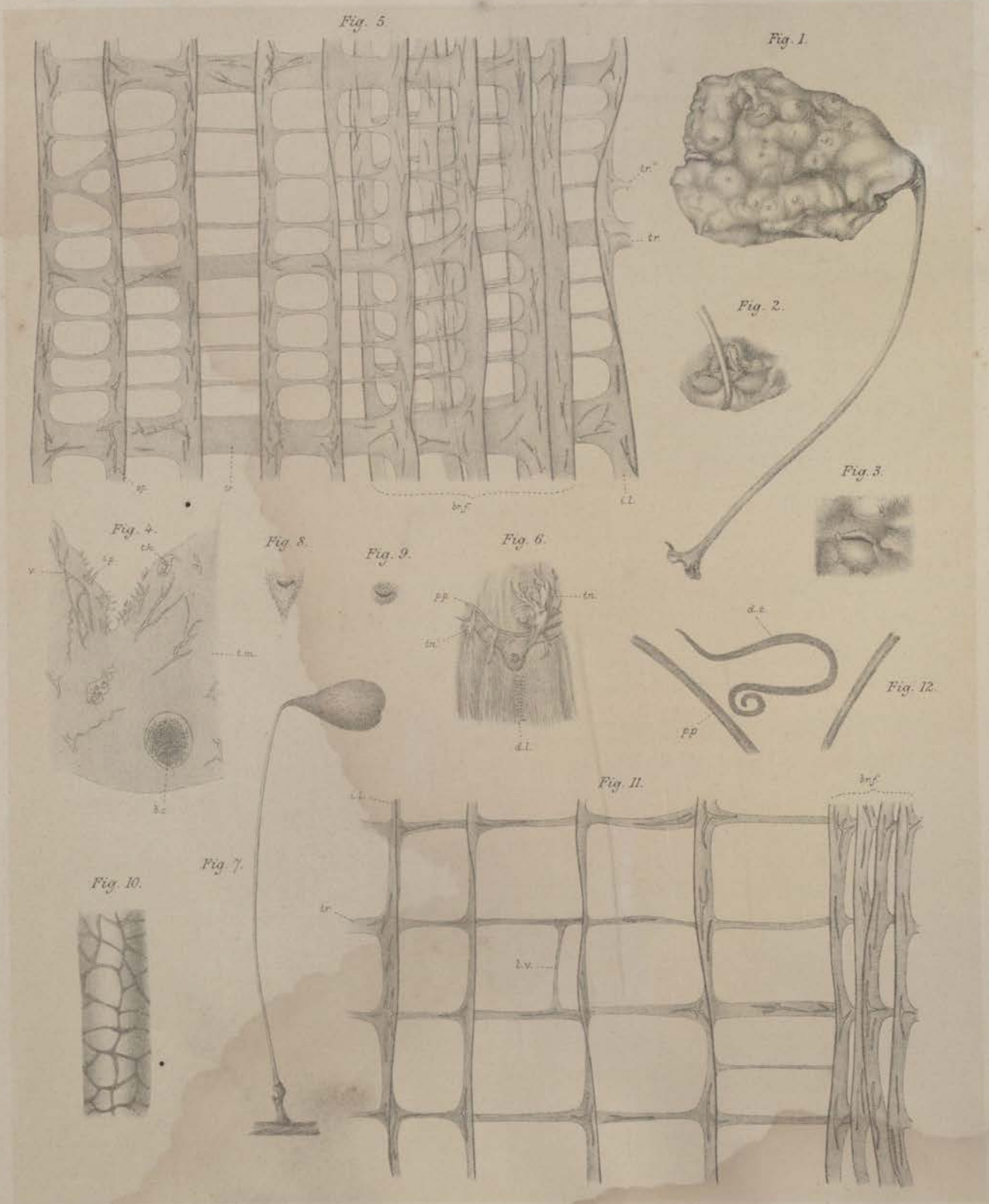
Fig. 8. The branchial aperture ; natural size.

Fig. 9. The atrial aperture ; natural size.

Fig. 10. Part of the peduncle, showing the brown trabeculæ ; enlarged.

Fig. 11. Part of the branchial sac, from the inside, showing one of the branchial folds (*br.f.*) ; magnified (Hartn., obj. 4).

Fig. 12. The dorsal tubercle and peritubercular area ; magnified (Hartn., obj. 4).



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FIGS. 1-6 CULEOLUS WYVILLE-THOMSONI, Herdman. FIGS. 7-12 C. MOSELEYI, Herdman.

PLATE XI.

PLATE XI.

Figs. 1–7. *Culeolus recumbens*, Herdman.
Figs. 8–9. *Culeolus perlatus*, Suhm.
Figs. 10–14. *Culeolus perlucidus*, Herdman.

Fig. 1. *Culeolus recumbens*, a specimen seen from the right side; natural size.

Fig. 2. Another specimen, from the left side; natural size.

Fig. 3. The branchial aperture of fig. 1; natural size.

Fig. 4. The atrial aperture of fig. 1; natural size.

Fig. 5. Part of the branchial sac, from the inside; magnified (Hartn., obj. 4).

Fig. 6. The dorsal part of the anterior end of the branchial sac, showing the peripharyngeal bands, the nerve ganglion, and the dorsal tubercle; magnified (Hartn., obj. 4).

Fig. 7. Dissection, showing the alimentary canal and the genitalia of both sides; slightly enlarged.

Fig. 8. *Culeolus perlatus*, from the left side; natural size.

Fig. 9. Part of the branchial sac, from the inside, showing a fold (*br.f.*); magnified (Hartn., obj. 4).

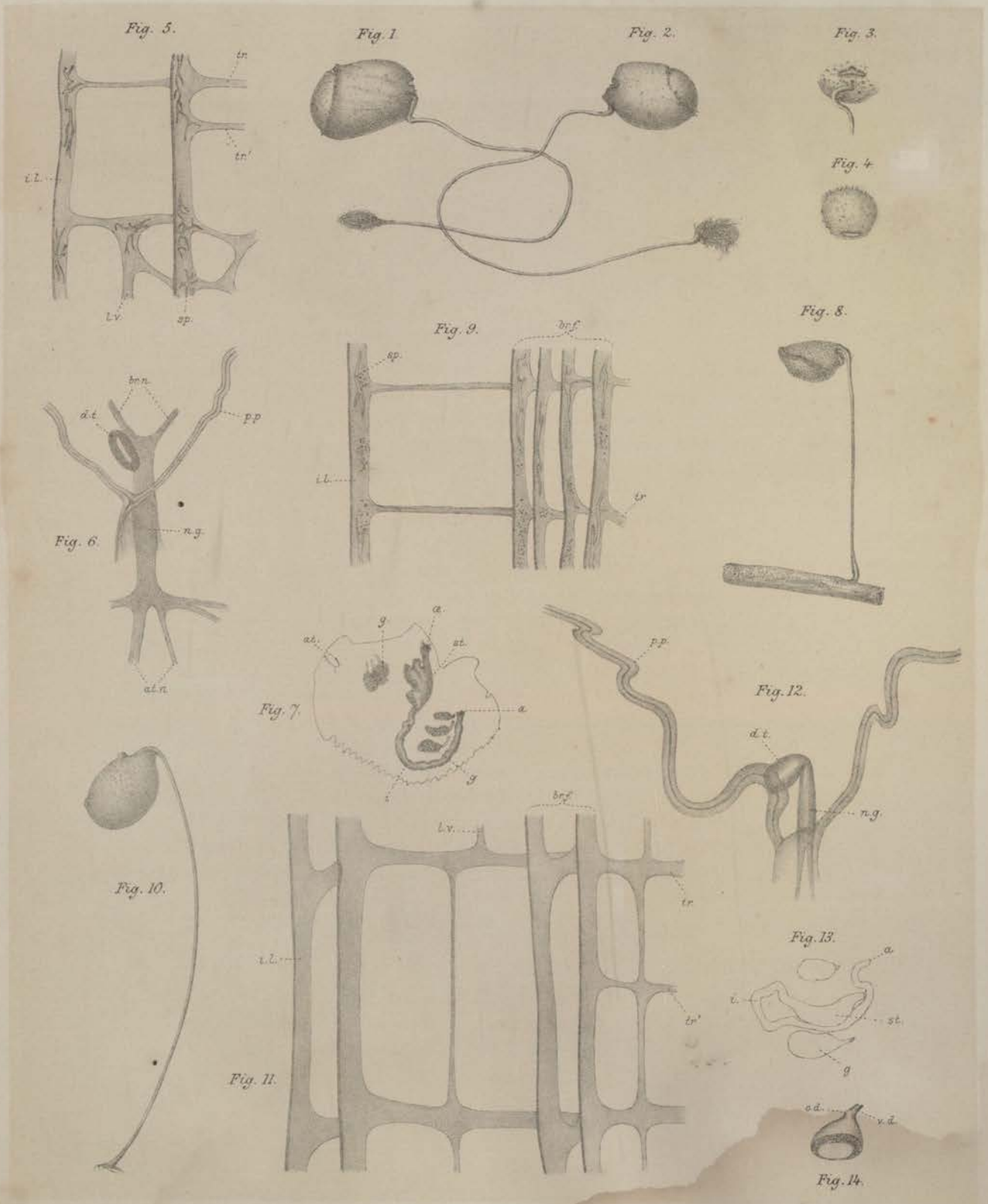
Fig. 10. *Culeolus perlucidus*, from the right side; natural size.

Fig. 11. Part of the branchial sac, from the inside; showing two of the simple folds (*br.f.*); magnified (Hartn., obj. 4).

Fig. 12. The dorsal part of the anterior end of the branchial sac, showing the peritubercular area, the dorsal tubercle, the peripharyngeal bands, and the nerve ganglion; magnified (Hartn., obj. 4).

Fig. 13. Outline of the alimentary canal and the genital glands; slightly enlarged.

Fig. 14. Part of one of the genital masses cut to show the hollow interior and the ducts; somewhat enlarged.



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FIGS. 1-7 CULEOLUS RECUMBENS, Herdman. FIGS. 8-9 C. PERLATUS, Suhm. FIGS. 10-14 C. PERLUCIDUS, Herdman.

PLATE XII

PLATE XII.

Figs. 1–7. *Culeolus recumbens*, Herdman.
Figs. 8–12. *Culeolus perlucidus*, Herdman.

Fig. 1. A section through the test of *Culeolus recumbens*, showing foreign particles imbedded in the outer part (left side of figure); magnified (Hartn., obj. 4).

Fig. 2. A transverse section through the peduncle of the same species, showing the cavities (*ped.c.*), and the imbedded foreign particles; magnified (Hartn., obj. 4).

Fig. 3. Part of the branchial sac, from the inside, showing a fold (*br. f.*); magnified (Hartn., obj. 4).

Fig. 4. Part of the endostyle, showing the clear edges, with spicules, and the central opaque area; magnified (Hartn., obj. 4).

Fig. 5. Columnar cells from the brown band of the endostyle; much magnified (Hartn., obj. 7).

Fig. 6. The terminations of the genital ducts; magnified (Hartn., obj. 4).

Fig. 7. One of the genital glands, enlarged, showing the ducts.

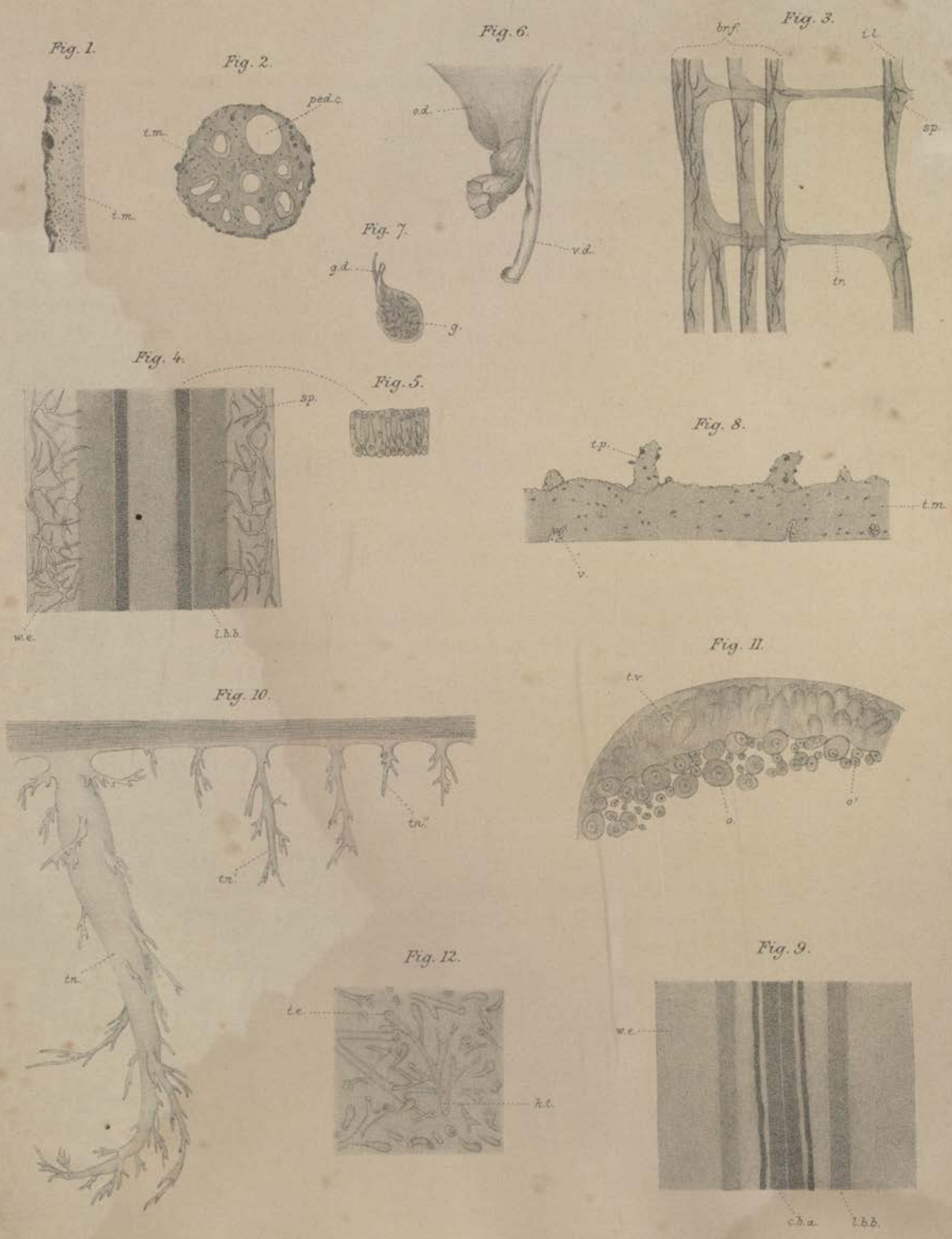
Fig. 8. A section through the test of *Culeolus perlucidus*, showing the papillæ on the outer surface; magnified (Hartn., obj. 4).

Fig. 9. Part of the endostyle, showing the clear edge (*w.e.*), and the central more opaque area (*c.b.a.*); magnified (Hartn., obj. 4).

Fig. 10. Part of the circlet of tentacles, showing three orders (*tn.*, *tn'.* and *tn.''*); magnified (Hartn., obj. 4).

Fig. 11. Part of a section through one of the genital glands, showing the spermatic vesicles externally, and the ova internally; magnified (Hartn., obj. 4).

Fig. 12. Part of the wall of the stomach, with the lining epithelium scraped off, showing the branched hepatic (?) tubules, with enlarged ends; much magnified (Hartn., obj. 7).



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FIGS. 1-7 CULEOLUS RECUMBENS, Herdman. FIGS. 8-12 CULEOLUS PERLUCIDUS, Herdman.

PLATE XIII.

PLATE XIII.

Figs. 1 and 2. *Culeolus perlatus*, Suhm.
Figs. 3 and 4. *Culeolus moseleyi*, Herdman.
Figs. 5 and 6. *Culeolus wyville-thomsoni*, Herdman.
Figs. 7–10. *Fungulus cinereus*, n. sp.

Fig. 1. Part of the peduncle of *Culeolus perlatus*, showing the brown trabeculæ; enlarged.

Fig. 2. Part of the surface of the test, showing the papillæ; enlarged.

Fig. 3. Part of the endostyle of *Culeolus moseleyi*, showing the spicules (*sp.*), the clear edges (*w.e.*), and the central opaque area; magnified (Hartn., obj. 4).

Fig. 4. The nerve ganglion of *Culeolus moseleyi*, and the patch of spicules in the mantle over it; magnified (Hartn., obj. 4).

Fig. 5. A small part of the branchial sac of *Culeolus wyville-thomsoni*, seen from the outside; magnified (Hartn., obj. 4).

Fig. 6. Part of the endostyle of *Culeolus wyville-thomsoni*, showing the clear edge (*w.e.*) the calcareous spicules (*sp.*), and the central area of opaque brown bands; magnified (Hartn., obj. 4).

Fig. 7. *Fungulus cinereus*, from the right side; natural size.

Fig. 8. The branchial aperture; enlarged.

Fig. 9. Part of the branchial sac, seen from the inside, showing one of the branchial folds (*br.f.*); magnified (Hartn., obj. 4).

Fig. 10. Part of the endostyle, showing the clear edges (*w.e.*), and the central opaque area. The left side of the figure shows the sinuses injected with blood corpuscles; magnified (Hartn., obj. 4).

Fig. 1.

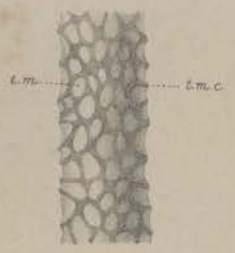


Fig. 7.

Fig. 8.

Fig. 3

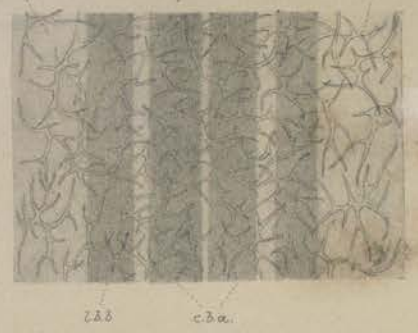


Fig. 2.

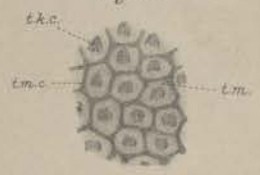


Fig. 6.

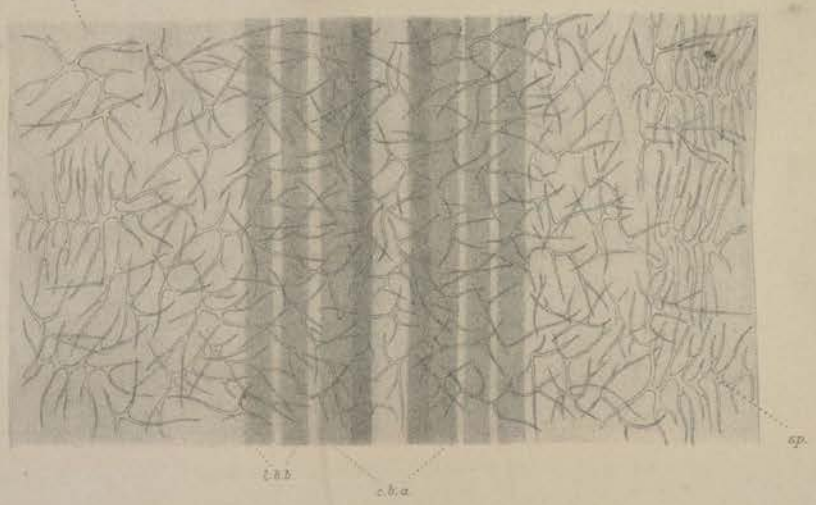


Fig. 5.

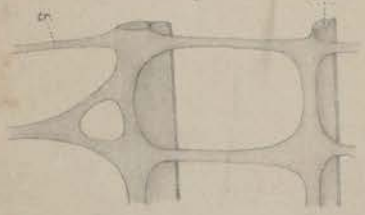


Fig. 4.

Fig. 9.

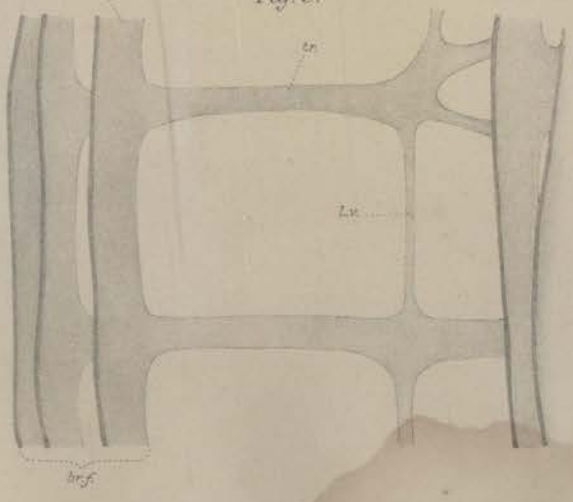
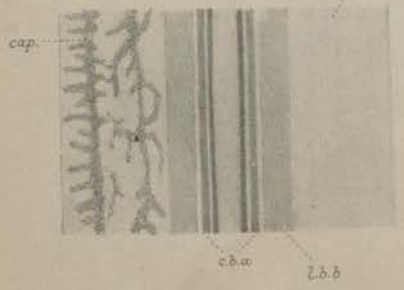


Fig. 10.



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FIGS. 1-2 CULEOLUS PERLATUS, von Suhm. FIGS. 3-4 CULEOLUS MOSELEYI, Herdman.
FIGS. 5-6 CULEOLUS WYVILLE-THOMSONI, Herdman. FIGS. 7-10 FUNGULUS CINEREUS, n. sp.

PLATE XIV.

PLATE XIV.

Figs. 1–4. *Microcosmus helleri*, Herdman.
Figs. 5 and 6. *Microcosmus propinquus*, Herdman.
Figs. 7 and 8. *Microcosmus polymorphus*, Heller.

Fig. 1. *Microcosmus helleri*, from the left side; natural size.

Fig. 2. Part of the branchial sac of the same, seen from the inside, to show the folds; natural size.

Fig. 3. Part of the branchial sac of the same, seen from the outside, to show the enormous transverse vessel (*tr. x.*); magnified (Hartn., obj. 4).

Fig. 4. Part of the branchial sac of the same, seen from the inside; magnified (Hartn., obj. 4).

Fig. 5. *Microcosmus propinquus*, from the left side; natural size.

Fig. 6. Part of the branchial sac of the same, seen from the inside; magnified (Hartn., obj. 4).

Fig. 7. Part of the branchial sac of *Microcosmus polymorphus*, seen from the inside, to show the folds; natural size.

Fig. 8. A portion of the same sac; magnified (Hartn., obj. 4).

Fig. 1.

Fig. 4.

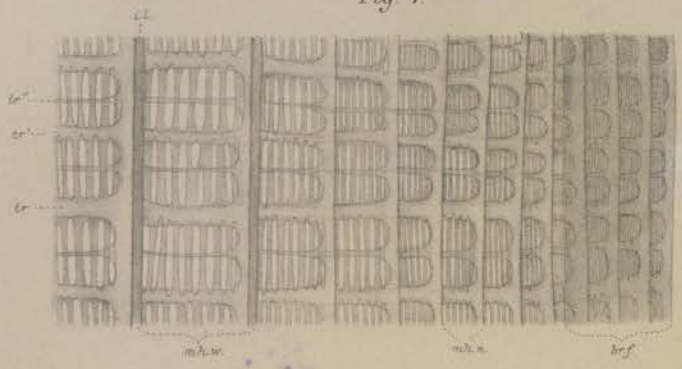


Fig. 2.

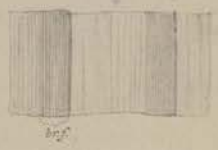


Fig. 3.

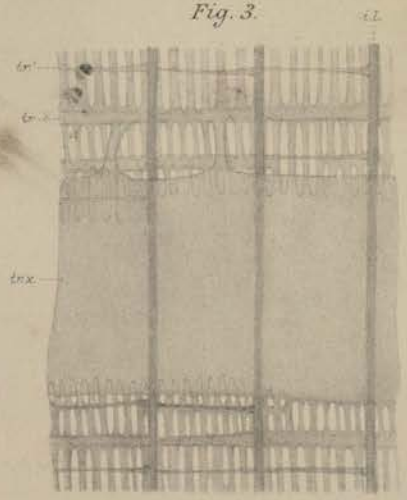


Fig. 5.

Fig. 7.

Fig. 8.

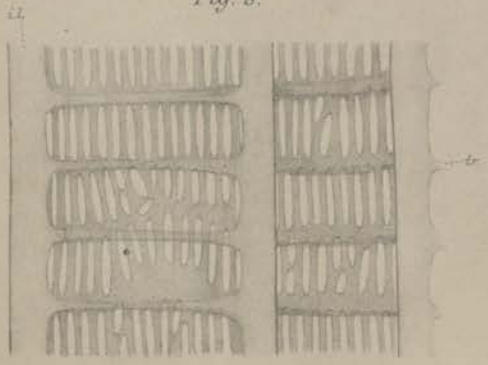
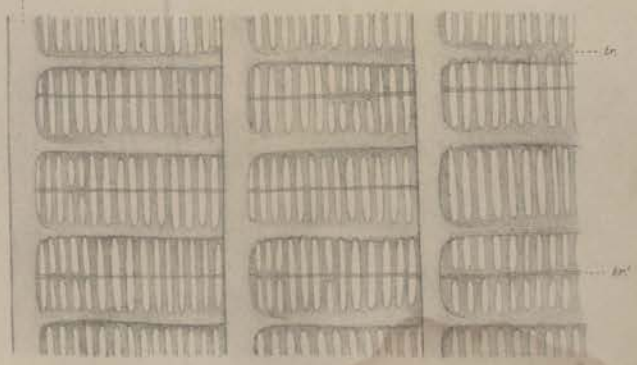


Fig. 6.



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FIG^S 1-4 MICROCOSMUS HELLERI, Herdman. FIG^S 5-6 M. PROPINQUUS, Herdman. FIG^S 7-8 M. POLYMORPHUS, Heller.

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PLATE XV.

PLATE XV.

Figs. 1–4. *Cynthia hispida*, Herdman.
Figs. 5–7. *Cynthia cerebriformis*, Herdman.
Figs. 8–11. *Cynthia fissa*, Herdman.

Fig. 1. *Cynthia hispida*, a specimen from the left side ; natural size.

Fig. 2. A part of the branchial sac, seen from the inside, showing a fold (*br. f.*) ; magnified (Hartn., obj. 4).

Fig. 3. Part of the dorsal lamina, showing the two series of languets (*l.* and *l.'*) ; magnified (Hartn., obj. 4).

Fig. 4. The dorsal tubercle ; natural size and enlarged.

Fig. 5. *Cynthia cerebriformis*, a specimen from the right side ; natural size.

Fig. 6. A part of the branchial sac, seen from the inside, showing a fold (*br. f.*) ; magnified (Hartn., obj. 4).

Fig. 7. The dorsal tubercle and part of the peritubercular area, &c. ; magnified (Hartn., obj. 4).

Fig. 8. *Cynthia fissa*, from the right side ; natural size.

Fig. 9. Part of the branchial sac of *Cynthia fissa* ; seen from the inside, and showing a fold ; magnified (Hartn., obj. 4).

Fig. 10. The dorsal tubercle and the peritubercular area of *Cynthia fissa*; magnified (Hartn., obj. 4).

Fig. 11. One of the tentacles of *Cynthia fissa*, showing the short papilla-like pinnæ ; magnified (Hartn., obj. 4).

Fig. 3.

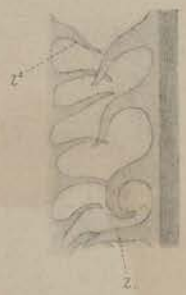


Fig. 1.

Fig. 2.

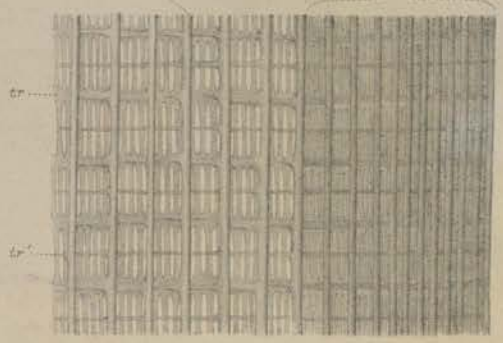


Fig. 4.

Nat. s.

Fig. 5.

Fig. 6.

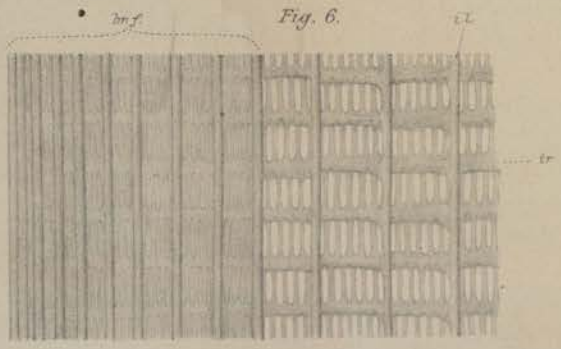


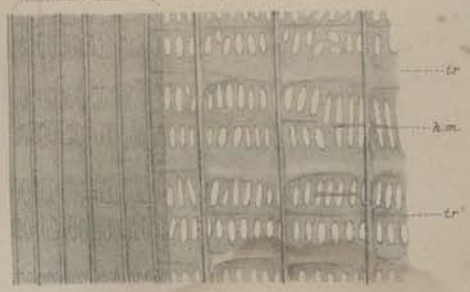
Fig. 7.

Fig. 8.

Fig. 11.

Fig. 10.

Fig. 9.



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FIG^s 1-4 CYNTHIA HISPIDA, Herdman. FIG^s 5-7 CYNTHIA CEREBRIFORMIS, Herdman.
FIG^s 8-11 CYNTHIA FISSA, Herdman.

PLATE XVI.

PLATE XVI.

Figs. 1–5. *Cynthia formosa*, Herdman.
Figs. 6–9. *Cynthia arenosa*, Herdman.
Figs. 10–12. *Cynthia irregularis*, Herdman.

Fig. 1. *Cynthia formosa*, from the right side; natural size.

Fig. 2. Part of the branchial sac of *Cynthia formosa*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 3. A small portion of the branchial sac of *Cynthia formosa*, seen from the inside, showing an irregularity; magnified (Hartn., obj. 4).

Fig. 4. Part of the dorsal lamina of *Cynthia formosa*, showing the marginal languets (*l.*); magnified (Hartn., obj. 4).

Fig. 5. The dorsal region of the anterior end of the branchial sac, showing the dorsal tubercle (*d.t.*), the peritubercular area, the præbranchial zone, and part of the circlet of tentacles (*tn.* and *tn'.*); magnified (Hartn., obj. 4).

Fig. 6. *Cynthia arenosa*, a specimen seen from the right side; natural size.

Fig. 7. Part of the branchial sac of *Cynthia arenosa*, seen from the inside, and showing two of the folds (*br.f.*), two interspaces, and part of the dorsal lamina (*l.*); magnified (Hartn., obj. 4).

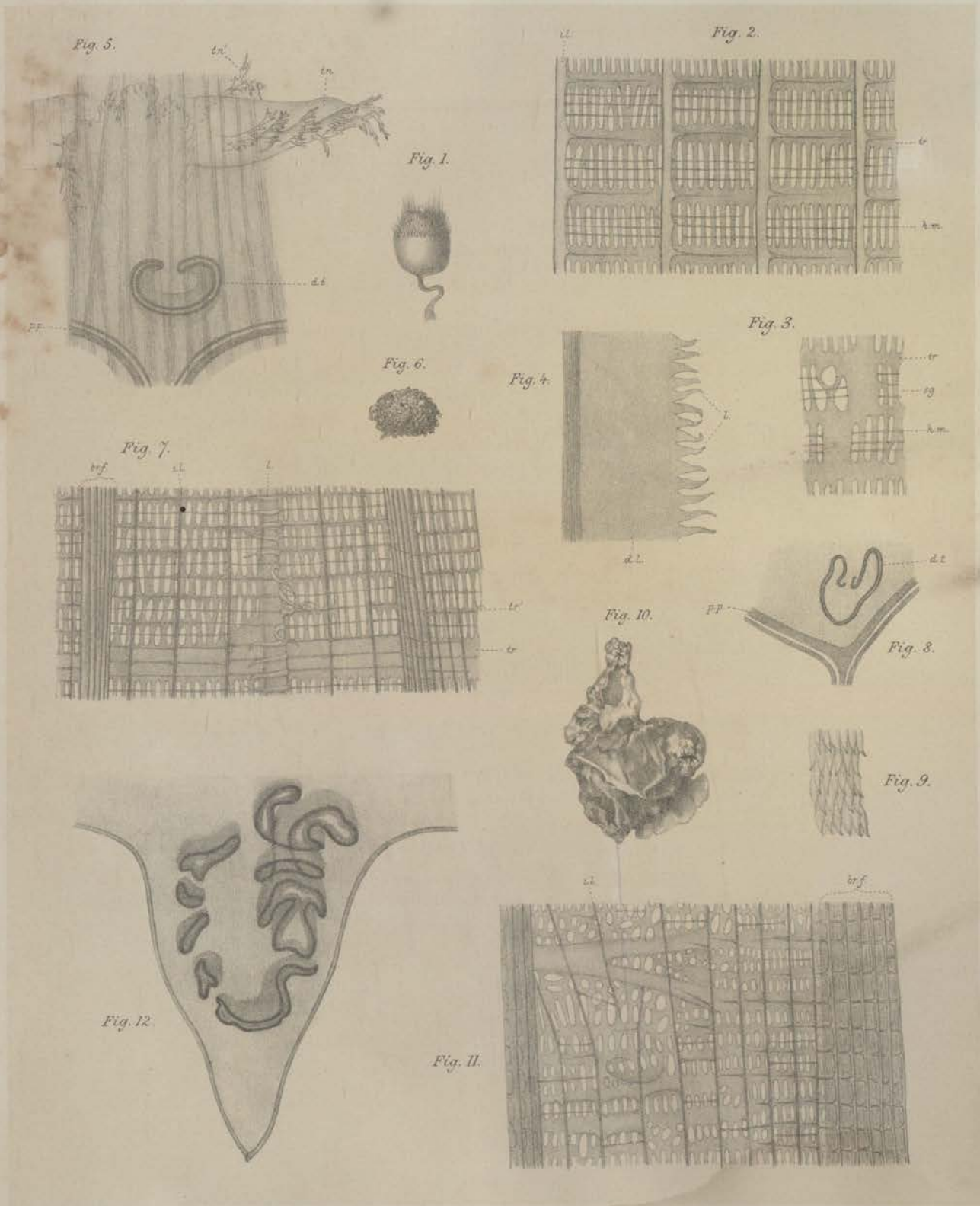
Fig. 8. The dorsal tubercle and peritubercular area of *Cynthia arenosa;* magnified (Hartn., obj. 4).

Fig. 9. A small portion of the modified test lining the branchial siphon of *Cynthia arenosa;* magnified (Hartn., obj. 5).

Fig. 10. *Cynthia irregularis*, from the left side; natural size.

Fig. 11. Part of the branchial sac of *Cynthia irregularis*, seen from the inside, and showing a fold (*br.f.*), and several irregular areas; magnified (Hartn., obj. 4).

Fig. 12. The peritubercular area and dorsal tubercle of *Cynthia irregularis;* magnified (Hartn., obj. 4).



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FIGS 1-5 CYNTHIA FORMOSA, Herdman. FIGS 6-9 C. ARENOSA, Herdman. FIGS 10-12 C. IRREGULARIS, Herdman.

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PLATE XVII.

PLATE XVII.

Figs. 1–9. *Cynthia complanata*, Herdman.
Figs. 10–16. *Cynthia papietensis*, n. sp.
Figs. 17–21. *Cynthia pallida*, Heller.

Fig. 1. *Cynthia complanata*, seen from the right side; natural size.

Fig. 2. A small portion of the test of *Cynthia complanata*, showing the calcareous spicules (*sp.*); magnified (Hartn., obj. 4).

Fig. 3. Some of the calcareous spicules from the test, enlarged to show the arrangement of the echinations; much magnified (Hartn., obj. 7).

Fig. 4. A small portion of the mantle, showing the musculature and the spicules; magnified (Hartn., obj. 4).

Fig. 5. Some of these calcareous spicules (*sp.*) enlarged, showing the membranous sheaths connecting them; much magnified (Hartn., obj. 7).

Fig. 6. Parts of these spicules and their sheaths; still more magnified to show details (Hartn., obj. 10).

Fig. 7. Part of the branchial sac, seen from the inside, showing two of the folds (*br.f.*) and the interspace; magnified (Hartn., obj. 4).

Fig. 8. Two of the calcareous spicules from the branchial sac in the last figure; much magnified (Hartn., obj. 7).

Fig. 9. The dorsal tubercle of *Cynthia complanata*, showing the convoluted course of the slit; enlarged.

Fig. 10. A small specimen of *Cynthia papietensis*, seen from the right side; natural size.

Fig. 11. A larger specimen of the same species, seen from the right side; natural size.

Fig. 12. Part of the branchial sac of *Cynthia papietensis*, seen from the inside, showing a fold (*br.f.*), an interspace, part of the dorsal lamina (*l.*), the dorsal tubercle (*d.t.*), and the peritubercular area; magnified (Hartn., obj. 4).

Fig. 13. Two of the calcareous spicules from the same branchial sac; much magnified (Hartn., obj. 7).

Fig. 14. Part of the test of *Cynthia papietensis*, showing the branched vessels (*v.*), terminating in knobs (*t.k.*), and the calcareous spicules (*sp.*); magnified (Hartn., obj. 4).

Fig. 15. Three of the calcareous spicules from the test in the last figure, much enlarged to show the screw-nail appearance (Hartn., obj. 7).

Fig. 16. Part of the circle of tentacles in *Cynthia papietensis*, showing three orders, two compound (*tn.* and *tn'.*), and one simple (*tn''.*); magnified (Hartn., obj. 4).

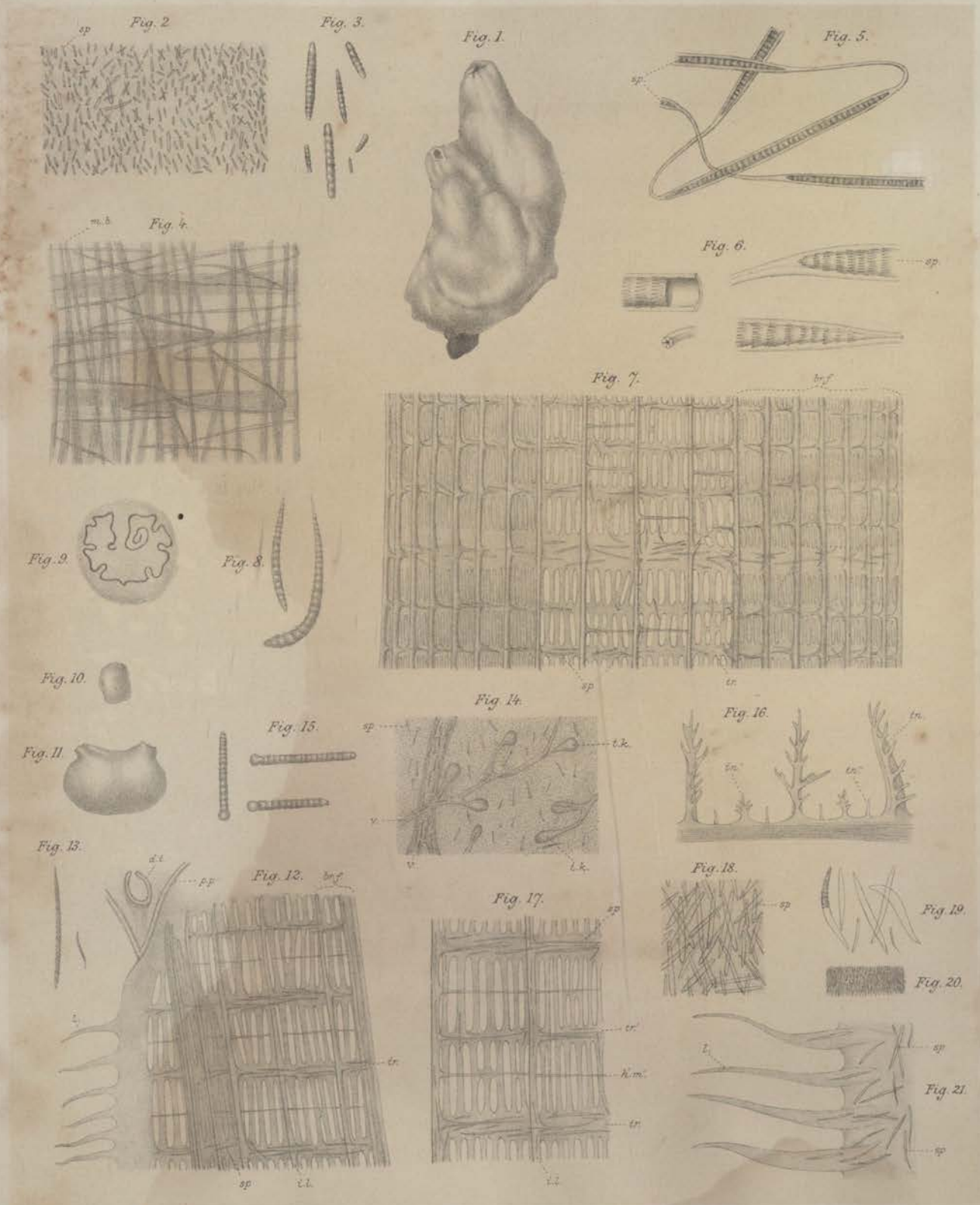
Fig. 17. Part of the branchial sac of *Cynthia pallida*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 18. A small portion of the mantle of *Cynthia pallida*, showing the calcareous spicules (*sp.*); magnified (Hartn., obj. 4).

Fig. 19. Some of these calcareous spicules, more enlarged (Hartn., obj. 7).

Fig. 20. A small portion of one of the spicules, still more enlarged, to show the arrangement of the minute echinations (Hartn., obj. 10).

Fig. 21. Part of the dorsal lamina of *Cynthia pallida*, showing the languets (*l.*), and the spicules (*sp.*); magnified (Hartn., obj. 4).



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FIGS 1-9 CYNTHIA COMPLANATA, Herdman. FIGS 10-16 C. PAPIETENSIS, n. sp. FIGS 17-21 C. PALLIDA, Heller.

PLATE XVIII.

PLATE XVIII.

Figs. 1–5. *Styela squamosa*, Herdman.
Figs. 1 and 6–8. *Styela bythia*, Herdman.

Fig. 1. A black manganese nodule, to which are attached a Brachiopod and two species of *Styela*. The upper specimen is *Styela squamosa*, the lower is *Styela bythia*; natural size. (From a drawing by Mr. George West.)

Fig. 2. Part of the branchial sac of *Styela squamosa*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 3. Part of the circle of tentacles of *Styela squamosa*, showing two sizes (*tn*: and *tn.'*); magnified (Hartn., obj. 4).

Fig. 4. Small portion of the branchial sac of *Styela squamosa*, showing a fold (*br.f.*), seen from the inside; magnified (Hartn., obj. 4).

Fig. 5. Another part of the branchial sac of *Styela squamosa*, seen from the inside, showing a piece of the dorsal lamina (*d.l.*); magnified (Hartn., obj. 4).

Fig. 6. Part of the branchial sac of *Styela bythia*, seen from the inside, showing the closely-placed and crumpled internal longitudinal bars (*i.l.*); magnified (Hartn., obj. 4).

Fig. 7. A small portion of the last figure, much magnified, to show the wavy outline of the stigmata (Hartn., obj. 5).

Fig. 8. Part of the dorsal lamina of *Styela bythia*, showing the languets (*l.*); magnified (Hartn., obj. 4).

Fig. 3.

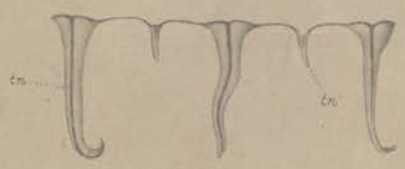


Fig. 2.

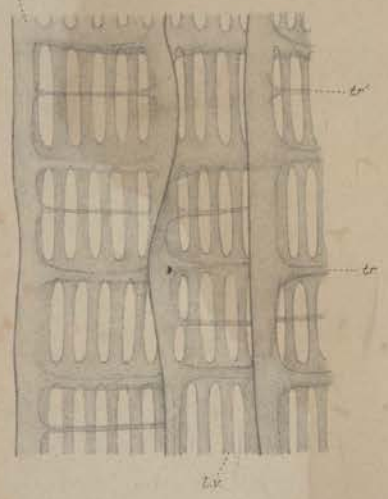


Fig. 1.

Fig. 4.

Fig. 5.

Fig. 6.

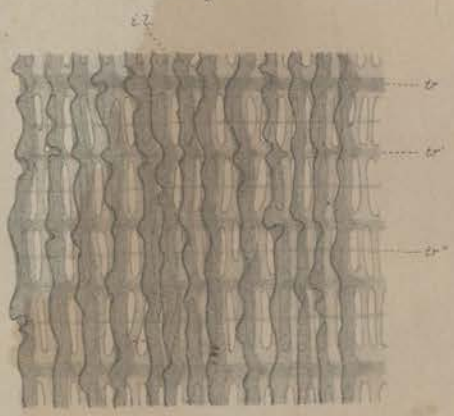
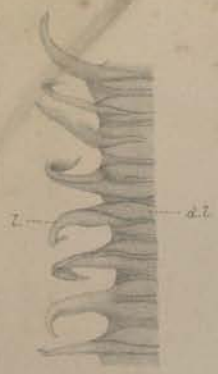


Fig. 7.

Fig 8.



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FIGs 1-5 STYELA SQUAMOSA, Herdman. FIGs 1 and 6-8 STYELA BYTHIA, Herdman.

PLATE XIX.

PLATE XIX.

Figs. 1 and 2. *Styela grandis*, Herdman.
Figs. 3 and 4. *Styela convexa*, Herdman.
Figs. 5 and 6. *Styela exigua*, Herdman.
Figs. 7 and 8. *Styela lactea*, Herdman.
Figs 9 and 10. *Styela clava*, Herdman.

Fig. 1. *Styela grandis*, a specimen seen from the left side ; natural size.

Fig. 2. Part of the branchial sac of *Styela grandis*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 3. *Styela convexa*, seen from the left side ; natural size.

Fig. 4. Part of the branchial sac of *Styela convexa*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 5. *Styela exigua*, from the right side ; natural size.

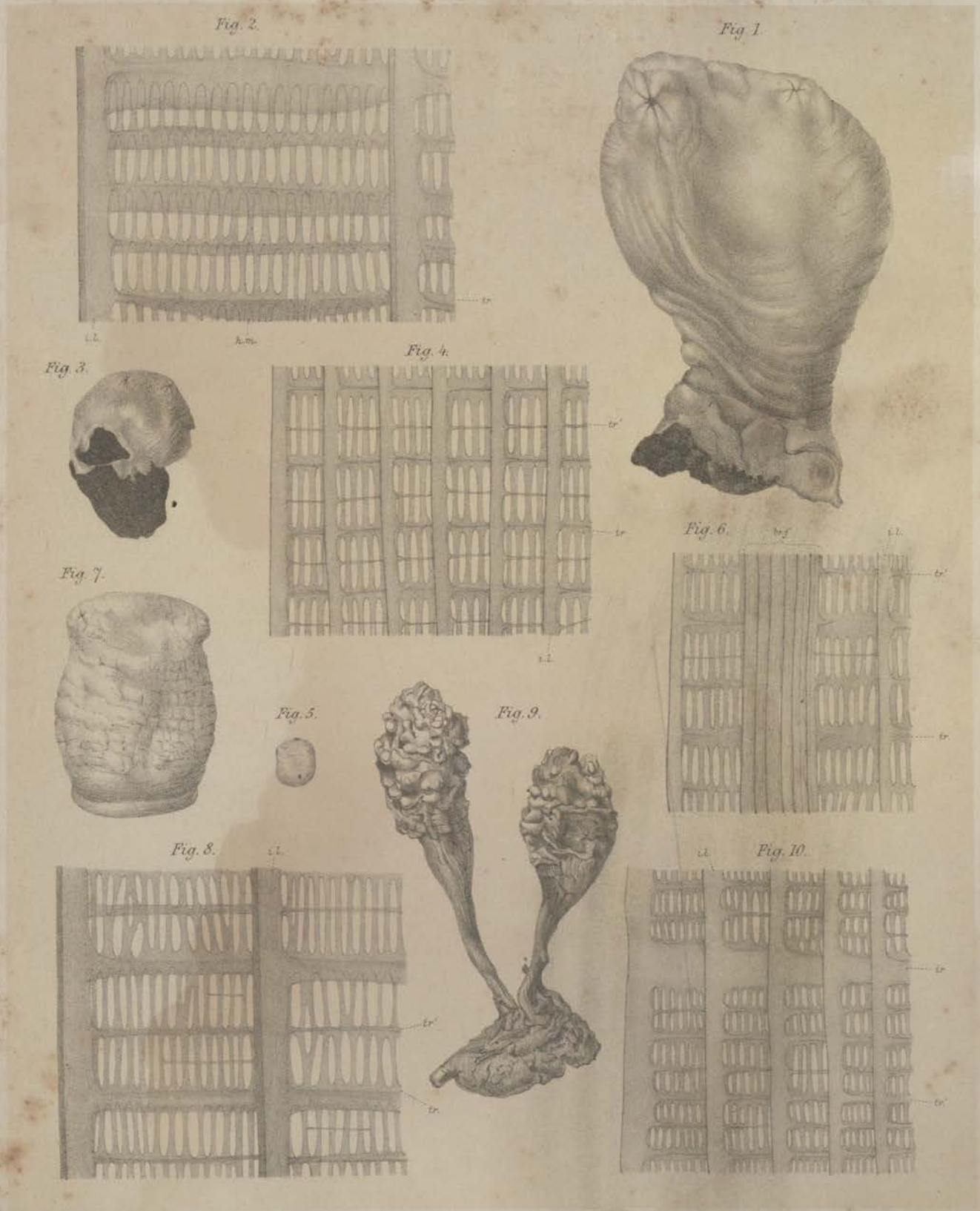
Fig. 6. Part of the branchial sac of *Styela exigua*, showing a fold (*br.f.*), seen from the inside ; magnified (Hartn., obj. 4).

Fig. 7. *Styela lactea*, a specimen from the right side ; natural size.

Fig. 8. Part of the branchial sac of *Styela lactea*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 9. Two specimens of *Styela clava* ; natural size.

Fig. 10. Part of the branchial sac of *Styela clava*, seen from the inside ; magnified (Hartn., obj. 4).



W. A. Herdman del.

P. Huth, Lith^r Edin^r

FIG^s 1-2 STYELA GRANDIS, Herdman. FIG^s 3-4 S. CONVEXA, Herdman. FIG^s 5-6 S. EXIGUA, Herdman.
FIG^s 7-8 S. LACTEA, Herdman. FIG^s 9-10 S. CLAVA, Herdman.

PLATE XX.

PLATE XX.

Figs. 1–6. *Styela flava*, Herdman.
Figs. 7–9. *Styela oblonga*, Herdman.
Figs. 10–13. *Styela glans*, Herdman.

Fig. 1. *Styela flava*, from the dorsal edge; natural size.

Fig. 2. A small portion of the test of *Styela flava*, surface view; magnified (Hartn., obj. 4).

Fig. 3. A small portion of the mantle of *Styela flava*, showing the musculature; magnified (Hartn., obj. 4).

Fig. 4. Part of the branchial sac of *Styela flava*, showing a fold (*br.f.*), seen from the inside; magnified (Hartn., obj. 4).

Fig. 5. A small part of the dorsal lamina, showing the denticulations and ribs; magnified (Hartn., obj. 4).

Fig. 6. The dorsal region of the anterior end of the branchial sac, showing the dorsal tubercle (*d.t.*), the peritubercular area, and part of the circle of tentacles (*tn.*, *tn'.* and *tn''.*); magnified (Hartn., obj. 4).

Fig. 7. *Styela oblonga*, from the right side; natural size.

Fig. 8. Part of the branchial sac of *Styela oblonga*, showing a fold (*br.f.*), seen from the inside; magnified (Hartn., obj. 4).

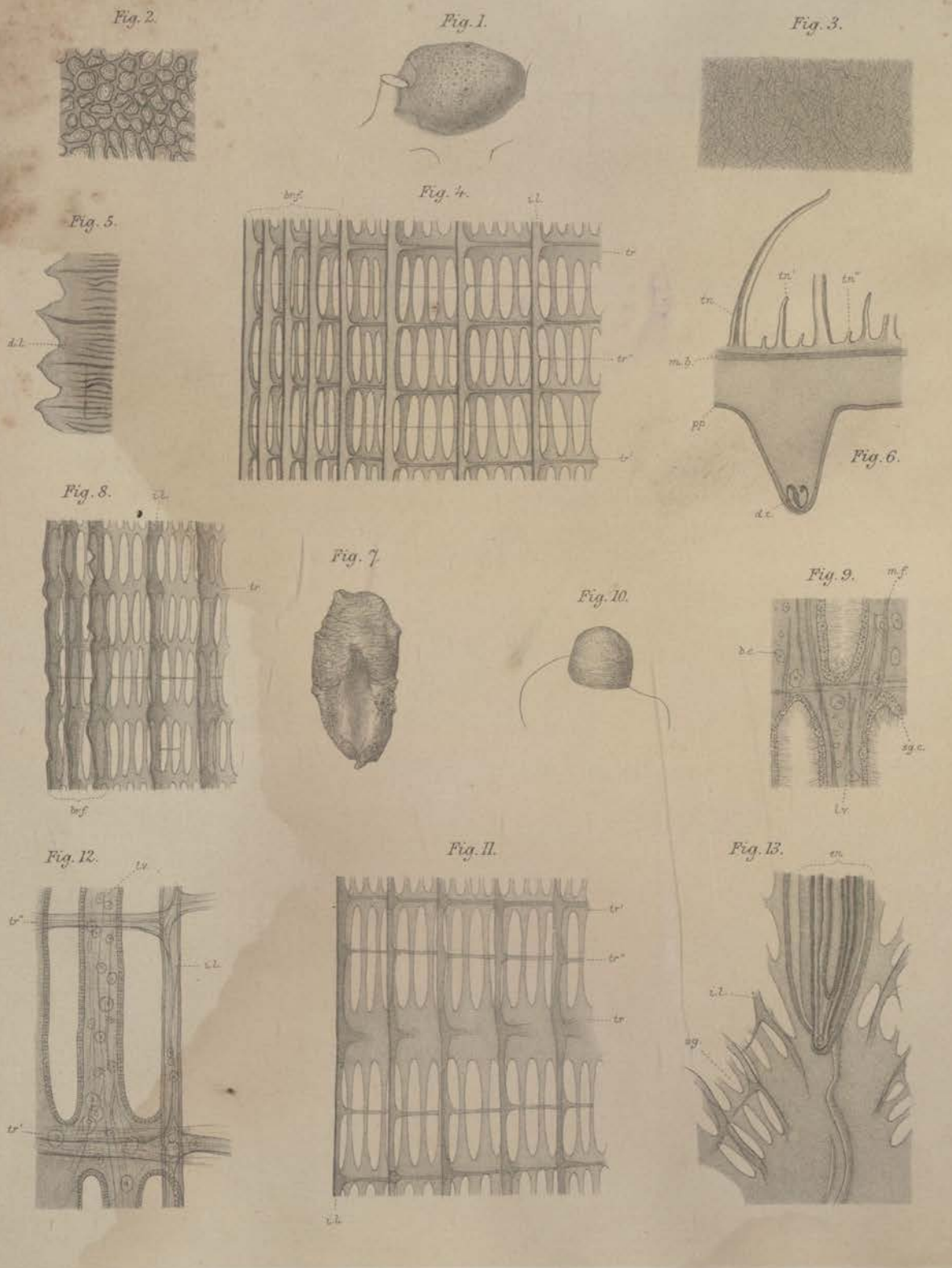
Fig. 9. A small portion of the last figure, much enlarged, to show the stigmatic cells (*sg.c.*), and the muscular fibres (*m.f.*) (Zeiss., obj. $\frac{1}{12}$).

Fig. 10. *Styela glans*, from the right side; natural size.

Fig. 11. Part of the branchial sac of *Styela glans*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 12. A small portion of the last figure; much enlarged (Hartn., obj. 5).

Fig. 13. The posterior end of the ventral edge of the branchial sac, seen from the inside, showing the posterior extremity of the endostyle, and its continuation round the posterior end of the sac to join the end of the dorsal lamina; magnified (Hartn., obj. 4).



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FIGS 1-6 STYELA FLAVA, Herdman. FIGS 7-9 S. OBLONGA, Herdman.
FIGS 10-13 S. GLANS, Herdman.

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PLATE XXI.

PLATE XXI.

Figs. 1–6. *Polycarpa tinctor*, Quoy and Gaimard.
Figs. 7–14. *Polycarpa viridis*, Herdman.

Fig. 1. *Polycarpa tinctor*, a specimen from the left side; natural size.

Fig. 2. Another specimen from the right side; natural size.

Fig. 3. The anterior end of another specimen; natural size.

Fig. 4. Part of the branchial sac of *Polycarpa tinctor*, showing a fold (*br.f.*), seen from the inside; magnified (Hartn., obj. 4).

Fig. 5. A small portion of the last figure; more enlarged (Hartn., obj. 5).

Fig. 6. The dorsal end of the anterior extremity of the branchial sac, showing the dorsal tubercle (*d.t.*), and part of the circle of tentacles (*tn.*); slightly enlarged.

Fig. 7. *Polycarpa viridis*, a specimen from the right side; natural size.

Fig. 8. Another specimen, seen from the right side; natural size.

Fig. 9. A small part of the test of *Polycarpa viridis*, showing the network of vessels (*v.*); magnified (Hartn., obj. 4).

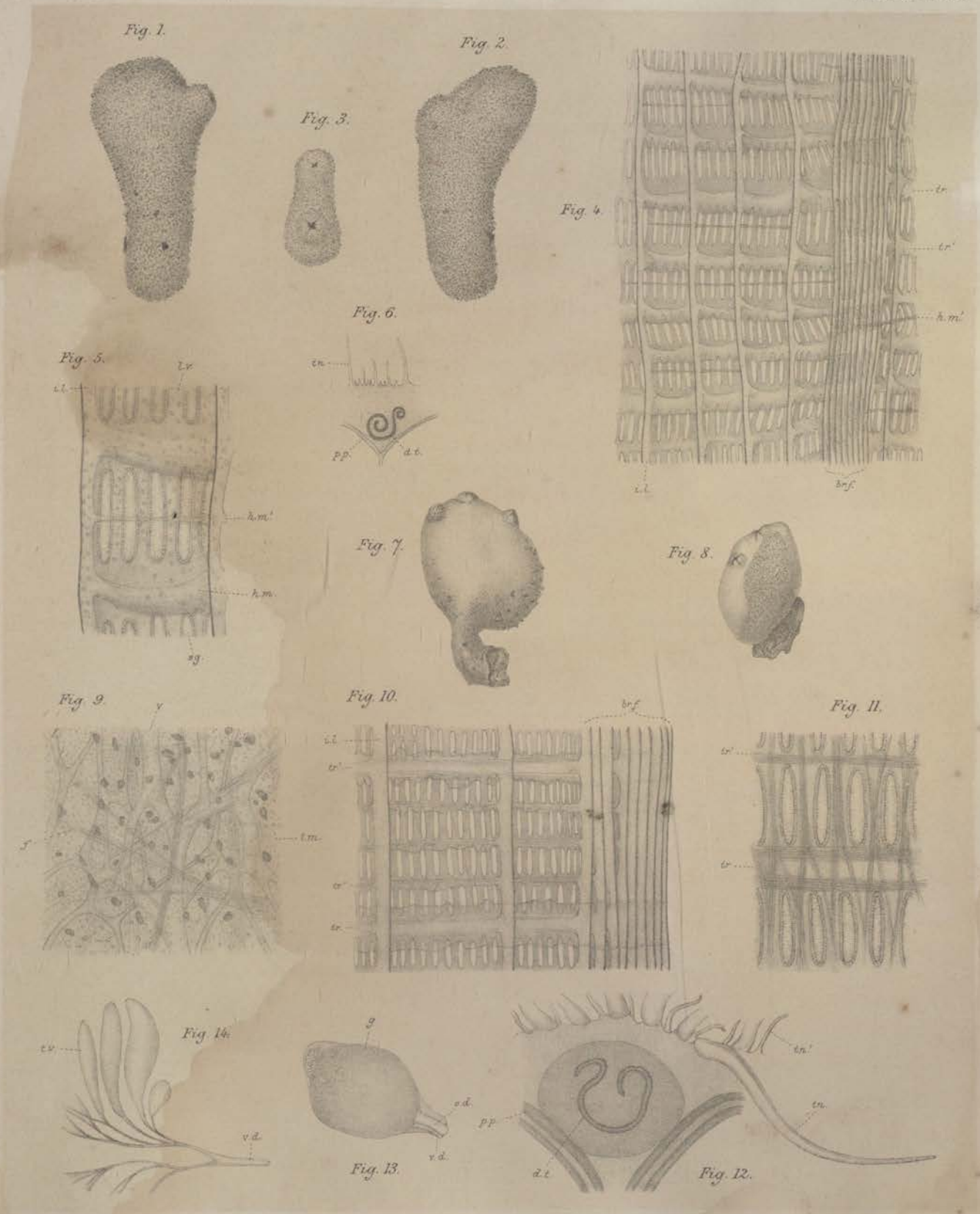
Fig. 10. Part of the branchial sac of *Polycarpa viridis*, showing a fold (*br.f.*), seen from the inside; magnified (Hartn., obj. 4).

Fig. 11. A small part of the last figure, more highly magnified, showing the arrangement of the muscular bundles (Hartn., obj. 5).

Fig. 12. The dorsal tubercle (*d.t.*), the peritubercular area, and part of the circle of tentacles (*tn.* and *tn.'*), of *Polycarpa viridis;* magnified (Hartn., obj. 4.)

Fig. 13. One of the "polycarps," showing the ovary and the oviduct (*o.d.*), and vas deferens (*v.d.*); magnified (Hartn. obj. 4).

Fig. 14. A small portion of the testicular part of the polycarp, showing the testicular vesicles (*t.v.*), and the vas deferens (*v.d.*); highly magnified (Hartn., obj. 5).



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FIGS. 1-6. POLYCARPA TINCTOR, Quoy and Gaimard. FIGS. 7-14. POLYCARPA VIRIDIS, Herdman.

PLATE XXII.

PLATE XXII.

Figs. 1–4. *Polycarpa minuta*, Herdman.
Figs. 5–7. *Polycarpa molguloides*, Herdman.
Figs. 8–10. *Polycarpa quadrata*, Herdman.
Figs. 11–15. *Polycarpa pilella*, Herdman.

Fig. 1. *Polycarpa minuta;* natural size.

Fig. 2. Part of the branchial sac of *Polycarpa minuta*, seen from the inside, showing a fold (*br.f.*); magnified (Hartn., obj. 4).

Fig. 3. One of the "polycarps" of *Polycarpa minuta;* enlarged.

Fig. 4. A small portion of the last figure, much magnified, showing the ova (*o.*) and the calcareous spicules (*sp.*) (Zeiss. obj. $\frac{1}{12}$).

Fig. 5. *Polycarpa molguloides*, a specimen of the natural size, showing the outer coating of sand.

Fig. 6. Part of the branchial sac of *Polycarpa molguloides*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 7. Another small portion, showing the wide internal longitudinal bar (Hartn., obj. 4).

Fig. 8. *Polycarpa quadrata*, a specimen seen from the right side; natural size.

Fig. 9. Part of the branchial sac of *Polycarpa quadrata*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 10. A small portion of the same branchial sac, more enlarged, showing the mode of junction of the horizontal membrane (*h.m.*) with the longitudinal vessels (*l.v.*) and the internal longitudinal bars (*i.l.*) (Hartn., obj. 5).

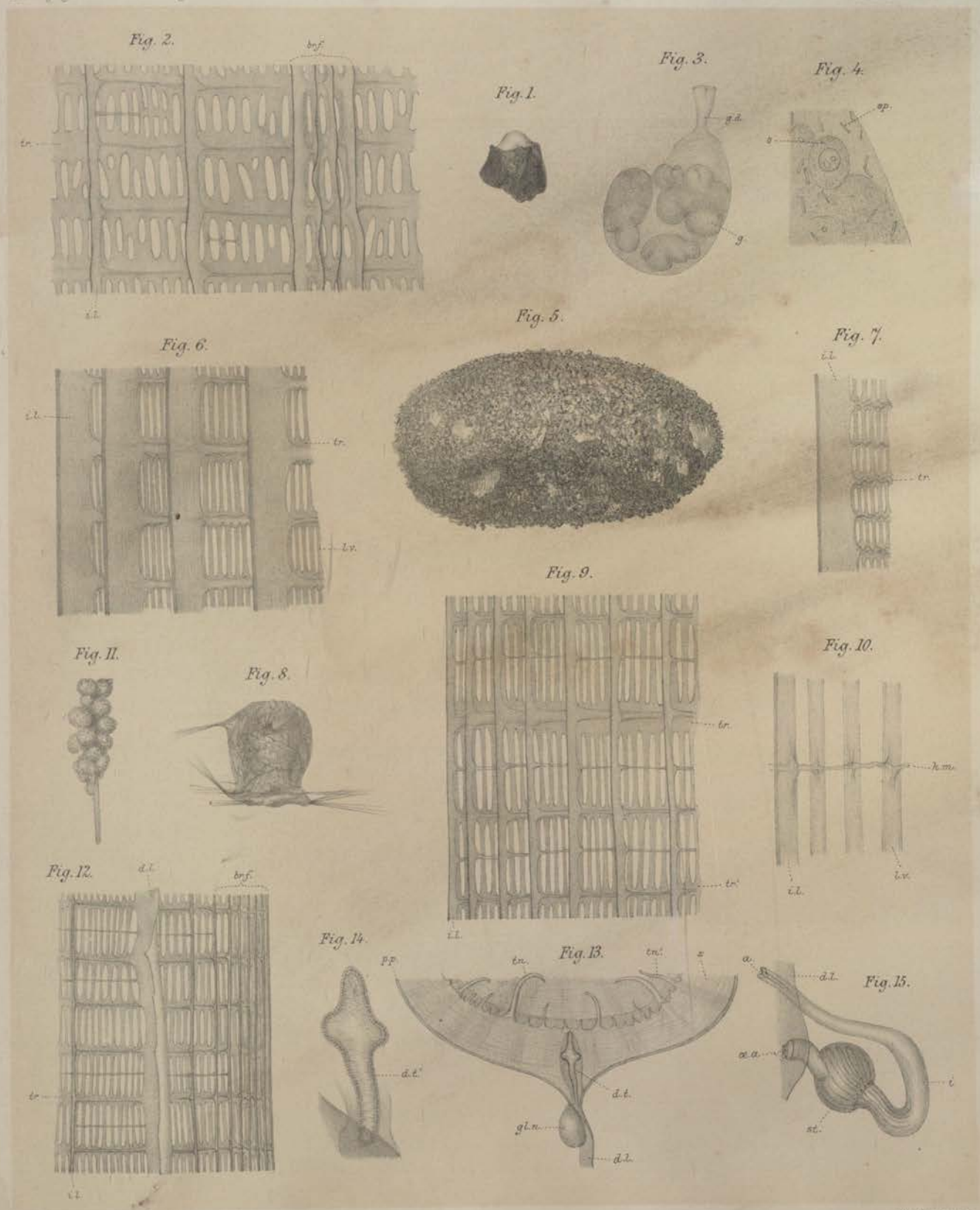
Fig. 11. A number of specimens of *Polycarpa pilella;* natural size.

Fig. 12. A small portion of the branchial sac of *Polycarpa pilella*, showing a fold (*br.f.*), and part of the dorsal lamina (*d.l.*), seen from the inside; magnified (Hartn., obj. 4).

Fig. 13. The dorsal part of the posterior end of the branchial siphon of *Polycarpa pilella*, seen from the inside, showing the dorsal tubercle (*d.t.*), the neural mass (*gl.n.*), part of the dorsal lamina (*d.l.*), the præbranchial zone (*z.*), and part of the circle of tentacles (*tn.* and *tn.'*); magnified (Hartn. obj. 4).

Fig. 14. The dorsal tubercle from the last figure, enlarged to show the ciliated cells round the aperture (Hartn., obj. 5).

Fig. 15. The alimentary canal of *Polycarpa pilella*, showing the œsophagus, stomach, and intestine; enlarged.



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FIGS 1-4 POLYCARPA MINUTA, Herdman. FIGS 5-7 P. MOLGULOIDES, Herdman.
FIGS 8-10 P. QUADRATA, Herdman. FIGS 11-15 P. PILELLA, Herdman.

PLATE XXIII.

PLATE XXIII.

Figs. 1 and 2. *Polycarpa rigida*, Herdman.
Figs. 3–6. *Polycarpa longisiphonica*, Herdman.
Figs. 7 and 8. *Polycarpa irregularis*, Herdman.
Figs. 9–13. *Polycarpa sulcata*, Herdman.

Fig. 1. *Polycarpa rigida*, a specimen seen from the left side ; natural size.

Fig. 2. Part of the branchial sac of *Polycarpa rigida*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 3. *Polycarpa longisiphonica*, from the left side ; natural size.

Fig. 4. Part of the branchial sac of *Polycarpa longisiphonica*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 5. The tip of one of the tentacles of *Polycarpa longisiphonica*, seen from the side ; magnified (Hartn., obj. 5).

Fig. 6. The same, seen partly from the front ; magnified (Hartn., obj. 5).

Fig. 7. *Polycarpa irregularis*, a specimen seen from the right side ; natural size.

Fig. 8. Part of the branchial sac of *Polycarpa irregularis*, seen from the inside ; magnified (Hartn., obj. 4).

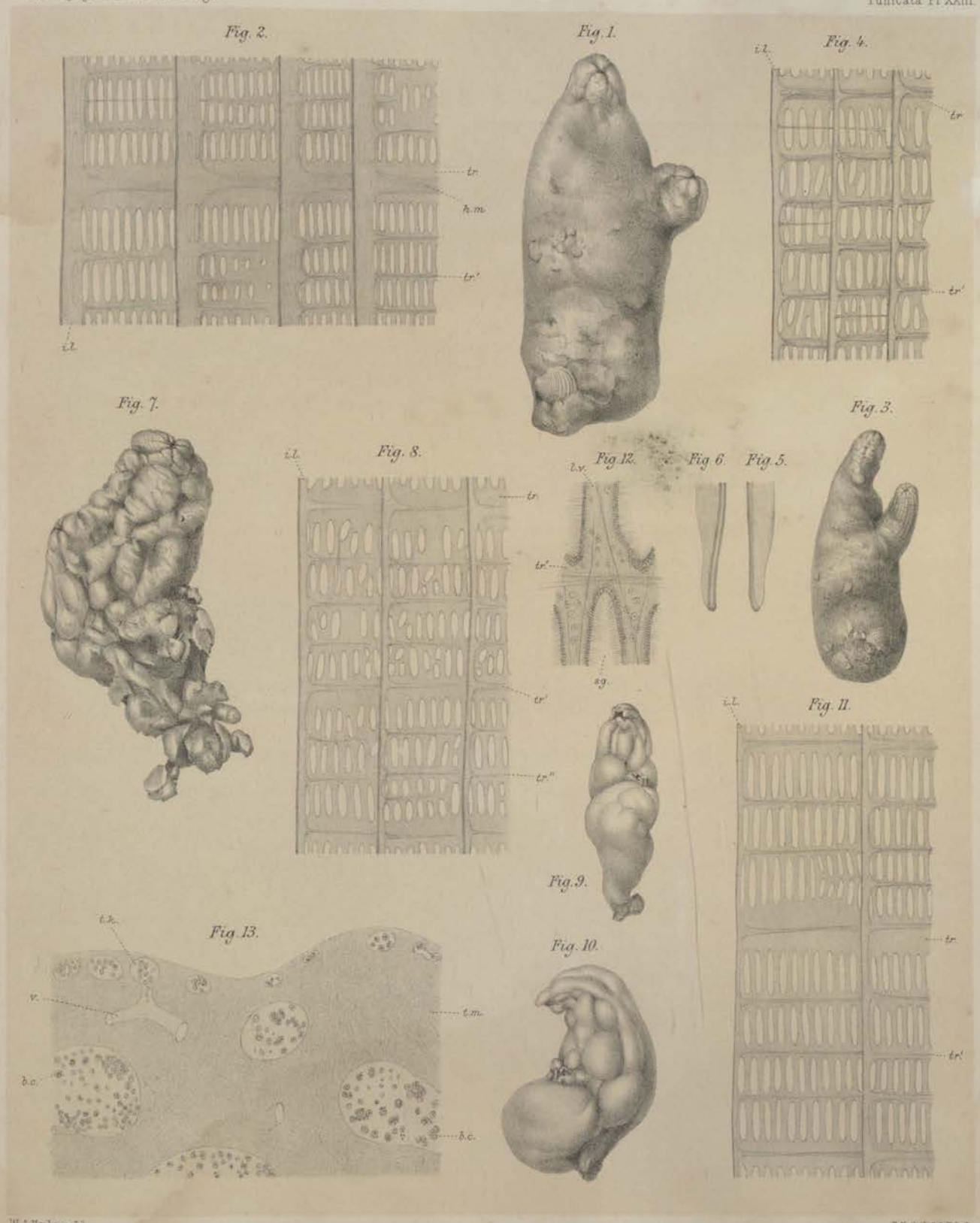
Fig. 9. *Polycarpa sulcata*, a specimen seen from the dorsal surface ; natural size.

Fig. 10. Another specimen, seen from the right side ; natural size.

Fig. 11. Part of the branchial sac of *Polycarpa sulcata*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 12. A small portion of the last figure, more magnified, and showing muscular fibres in the vessels (Hartn., obj. 7).

Fig. 13. Part of a section through the test of *Polycarpa sulcata*, showing the fibrous matrix (*t.m.*), the vessels (*v.*), and the cavities and terminal knobs (*t.k.*), containing blood corpuscles (Hartn., obj. 7).



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FIGS 1-2 POLYCARPA RIGIDA, Herdman. FIGS 3-6 P. LONGISIPHONICA, Herdman.

FIGS 7-8 P. IRREGULARIS, Herdman. FIGS 9-13 P. SULCATA, Herdman.

PLATE XXIV.

PLATE XXIV.

Figs. 1 and 2. *Polycarpa pedata*, Herdman.
Figs. 3–5. *Polycarpa radicata*, Herdman.
Figs. 6 and 7. *Styela radicosa*, n. sp.
Figs. 8–12. *Bathyoncus mirabilis*, n. sp.

Fig. 1. *Polycarpa pedata*, from the right side ; natural size.

Fig. 2. Part of the branchial sac of *Polycarpa pedata*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 3. *Polycarpa radicata*, a specimen seen from the right side ; natural size.

Fig. 4. Another specimen of the same species, from the left side ; natural size.

Fig. 5. Part of the branchial sac of *Polycarpa radicata*, showing a fold (*br.f.*), seen from the inside ; magnified (Hartn., obj. 4).

Fig. 6. *Styela radicosa*, from the right side ; natural size.

Fig. 7. Part of the branchial sac of *Styela radicosa*, seen from the inside ; magnified (Hartn., obj. 4).

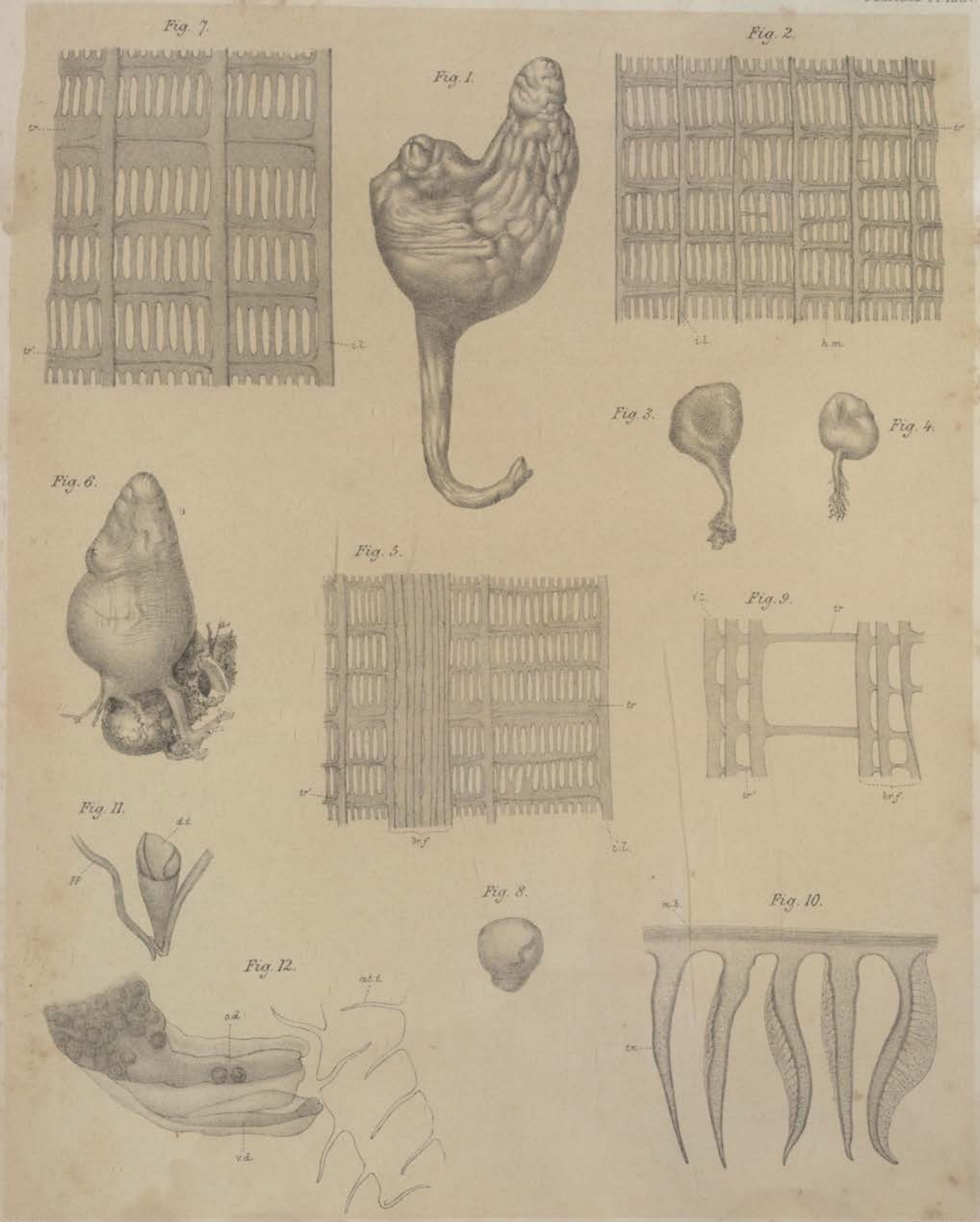
Fig. 8. *Bathyoncus mirabilis*, from the left side ; natural size.

Fig. 9. Part of the branchial sac of *Bathyoncus mirabilis*, showing two of the simple folds (*br.f.*), seen from the inside ; magnified (Hartn., obj. 4).

Fig. 10. Part of the circle of tentacles of *Bathyoncus mirabilis ;* magnified (Hartn., obj. 5).

Fig. 11. The dorsal tubercle (*d.t.*), and peritubercular area of *Bathyoncus mirabilis ;* magnified (Hartn., obj. 4).

Fig. 12. Part of the wall of the cloaca in *Bathyoncus mirabilis*, seen from the inside, and showing the terminations of the oviduct (*o.d.*) and vas deferens (*v.d.*), and part of the two circles of atrial tentacles (*at.t.*) ; magnified (Hartn., obj. 5).



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FIGS. 1-2 POLYCARPA PEDATA, Herdman. FIGS. 3-5 POLYCARPA RADICATA, Herdman.
FIGS. 6-7 STYELA RADICOSA, n. sp. FIGS. 8-12 BATHYONCUS MIRABILIS, n. sp.

PLATE XXV.

PLATE XXV.

Corynascidia suhmi, n. sp.

Fig. 1. *Corynascidia suhmi*, from the right side; natural size.

Fig. 2. A semi-diagrammatic figure of a dissection, from the right side, showing the relations of the viscera (stomach, intestine, genital gland, &c.) to the branchial sac; natural size.

Fig. 3. The alimentary and reproductive viscera of *Corynascidia suhmi*, seen from the ventral surface, showing the course of the intestine (*i.* and *r.*), and the position of the genital gland (*g.*) on the stomach (*st.*); natural size.

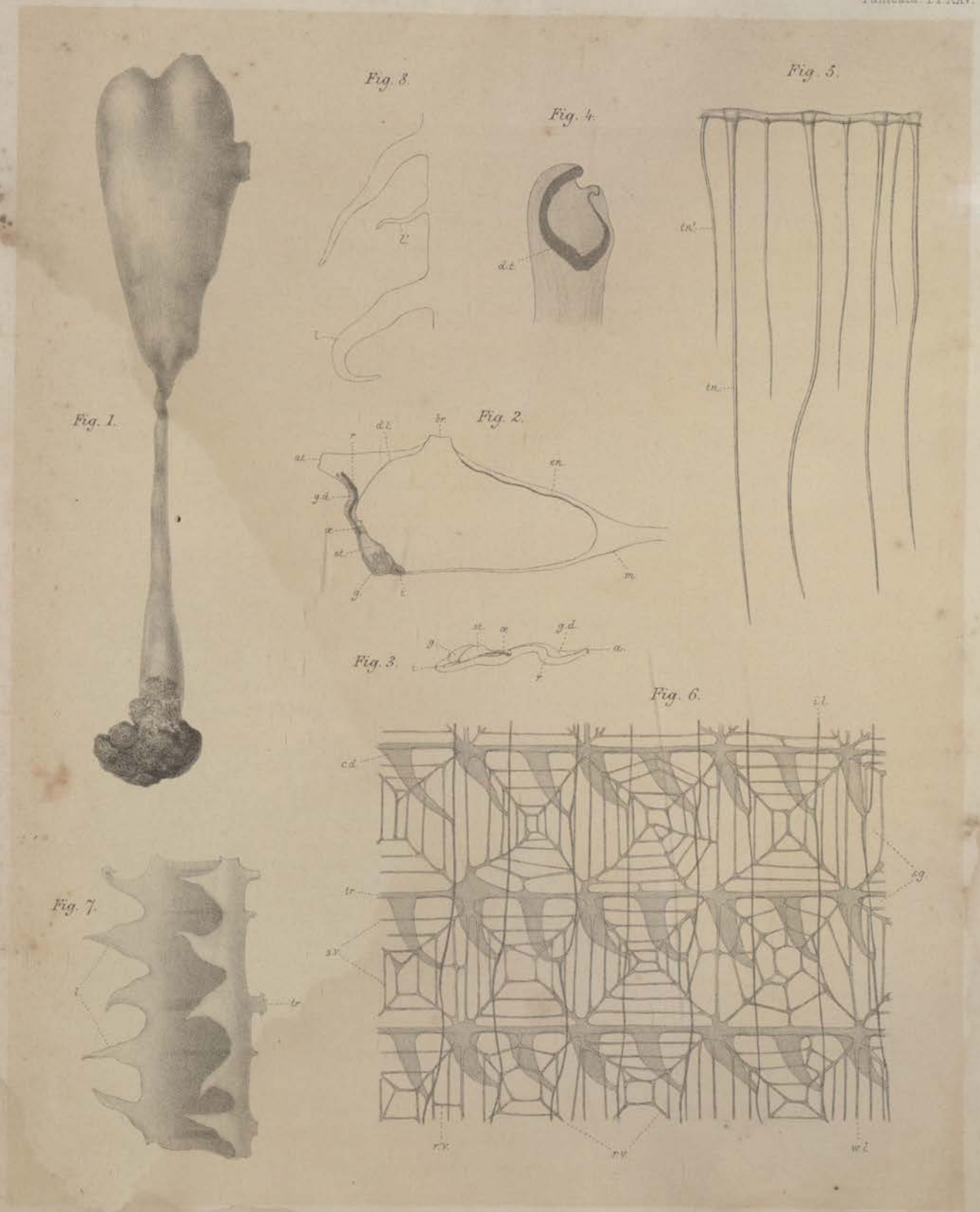
Fig. 4. The dorsal tubercle; magnified (Hartn., obj. 4).

Fig. 5. Part of the circle of tentacles, showing the two sizes (*tn.* and *tn.'*) alternately placed (Hartn., obj. 4).

Fig. 6. Part of the branchial sac of *Corynascidia suhmi*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 7. Part of the dorsal lamina, showing the double series of languets (*l.*); magnified (Hartn., obj. 4).

Fig. 8. Part of the dorsal lamina of another specimen, where the languets are longer, and are of two sizes, placed alternately; magnified (Hartn., obj. 4).



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CORYNASCIDIA SUHMI, n. sp.

PLATE XXVI.

PLATE XXVI.

Corella japonica, Herdman.

Fig. 1. *Corella japonica*, from the left side ; natural size.

Fig. 2. The same, with the test removed, seen from the left side, showing the musculature of the mantle ; natural size.

Fig. 3. The same, from the right side, showing the alimentary canal, &c. ; natural size.

Fig. 4. Part of the branchial sac, seen from the interior ; magnified (Hartn., obj. 4).

Fig. 5. A small portion of the branchial sac, seen from the outside ; much magnified (Hartn., obj. 5).

Fig. 6. Part of the musculature of the mantle ; magnified (Hartn., obj. 4).

Fig. 7. Part of the dorsal lamina showing the languets (*l.*) ; enlarged.

Fig. 8. The condition of the internal longitudinal bars in some parts of the branchial sac ; seen from the inside ; magnified (Hartn., obj. 4).

Fig. 9. The dorsal part of the anterior end of the branchial sac, showing the dorsal tubercle (*d.t.*) and the tentacles (*tn.*) ; magnified (Hartn., obj. 4).

Fig. 1.

Fig. 2.

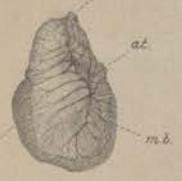


Fig. 3.

Fig. 4.

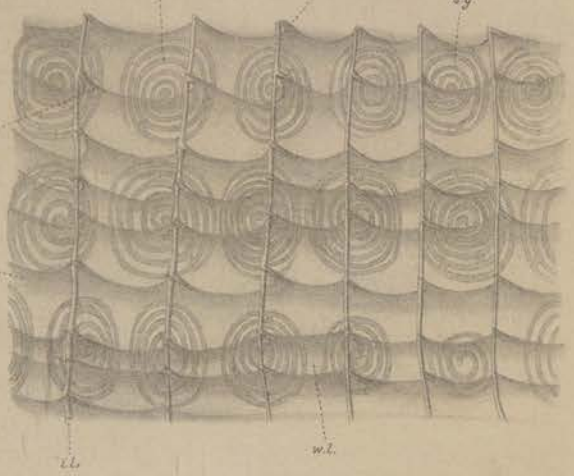


Fig. 8.

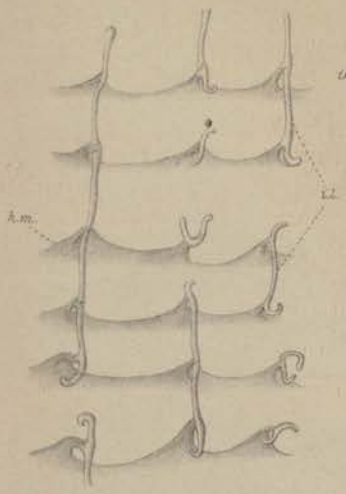
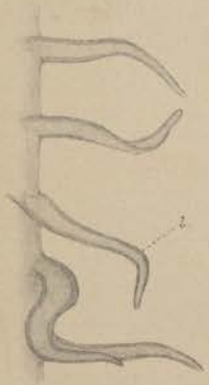


Fig. 7.



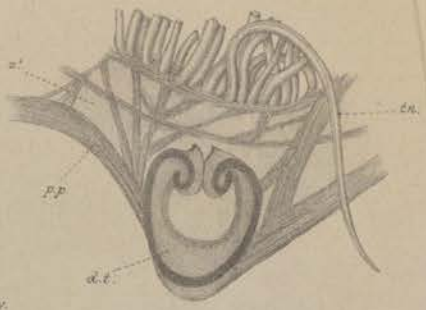
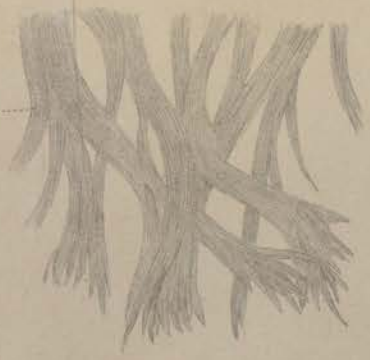


Fig. 5.

Fig. 9.

Fig. 6.



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F. Huth, Lith. Edin.

CORELLA JAPONICA, Herdman.

PLATE XXVII.

PLATE XXVII.

Abyssascidia wyvillii, Herdman.

Fig. 1. *Abyssascidia wyvillii*, from the upper or dorsal surface ; natural size.

Fig. 2. The same, from the lower or ventral surface ; natural size.

Fig. 3. The same, with the test removed ; seen from the right side, showing the mantle, with muscular bands, the alimentary canal, and the atrial siphon ; natural size.

Fig. 4. The same, from the left side, showing the muscular bands in the mantle and the branchial siphon ; natural size.

Fig. 5. The viscera, seen from the right side, showing the alimentary canal and the genital mass ; enlarged.

Fig. 6. The same, from the left side ; enlarged.

Fig. 7. Part of the branchial sac, seen from the inside ; magnified (Hartn., obj. 5).

Fig. 8. A small portion of the preceding figure ; greatly enlarged (Hartn., obj. 7).

Fig. 9. Part of an internal longitudinal bar, from fig. 7, showing the junction with a connecting duct (*c.d.*) ; greatly enlarged (Hartn., obj. 7).

Fig. 10. Epithelial cells from the surface of a horizontal membrane of the branchial sac ; much magnified (Hartn., obj. 10).

Fig. 11. Part of the series of dorsal languets ; magnified (Hartn., obj. 4).

Fig. 12. Anterior extremity of the endostyle (*en.*), and part of the tentacular circlet (*tn.*) ; magnified (Hartn., obj. 4).

Fig. 13. Another part of the tentacular circlet ; magnified (Hartn., obj. 4).

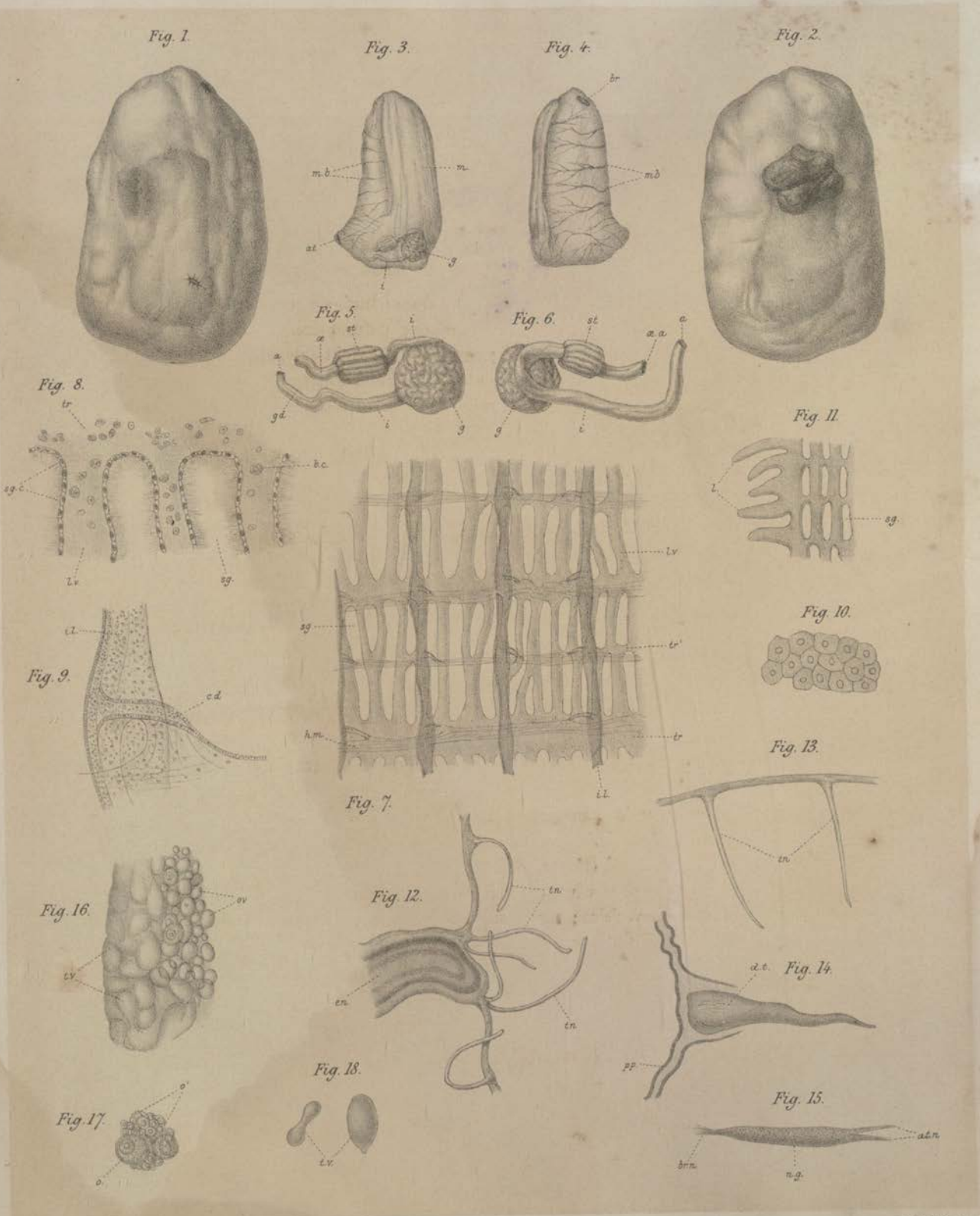
Fig. 14. The dorsal tubercle and peripharyngeal bands ; magnified (Hartn., obj. 4).

Fig. 15. The nerve ganglion ; magnified (Hartn., obj. 4).

Fig. 16. Part of the edge of the genital mass, showing testicular vesicles (*t.v.*), and ova (*ov.*) ; magnified (Hartn., obj. 4).

Fig. 17. Some of the ova ; much magnified (Hartn., obj. 7).

Fig. 18. Two testicular vesicles ; much magnified (Hartn., obj. 7).



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P. Roth, Lith. Edin.

ABYSSASCIDIA WYVILLII, Herdman.

ROYAL ASIATIC SOCIETY LIBRARY OF THE BOMBAY BRANCH OF THE

PLATE XXVIII.

PLATE XXVIII.

Figs. 1–5. *Pachychlæna obesa*, Herdman.
Figs. 6–11. *Pachychlæna gigantea*, Herdman.

Fig. 1. *Pachychlæna obesa*, from the dorsal edge and part of the right side; the greater part of the test has been removed; natural size.

Fig. 2. Part of the branchial sac of *Pachychlæna obesa*, seen from the interior; magnified (Hartn., obj. 4).

Fig. 3. Part of the same branchial sac, seen from the exterior; magnified (Hartn., obj. 4).

Fig. 4. A small portion of the last figure; more enlarged (Hartn., obj. 5).

Fig. 5. Part of the dorsal lamina; magnified (Hartn., obj. 4).

Fig. 6. *Pachychlæna gigantea*, from the left side; natural size.

Fig. 7. Part of the branchial sac of *Pachychlæna gigantea*, seen from the interior; magnified (Hartn., obj. 4).

Fig. 8. Part of the branchial sac, seen from the exterior, showing the external wide-meshed network, &c.; magnified (Hartn., obj. 4).

Fig. 9. The interior of the branchial siphon, showing the tentacles and the strong muscular ring; natural size.

Fig. 10. The dorsal tubercle, peripharyngeal band, peritubercular area, and tentacles; slightly enlarged.

Fig. 11. Part of the dorsal lamina of *Pachychlæna gigantea*; very slightly enlarged.

Fig. 2.

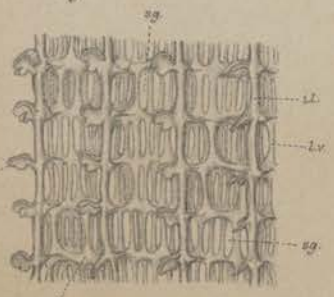

Fig. 1.

Fig. 4.

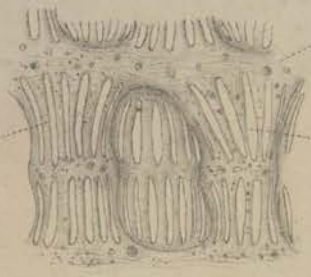

Fig. 3.

Fig. 8.

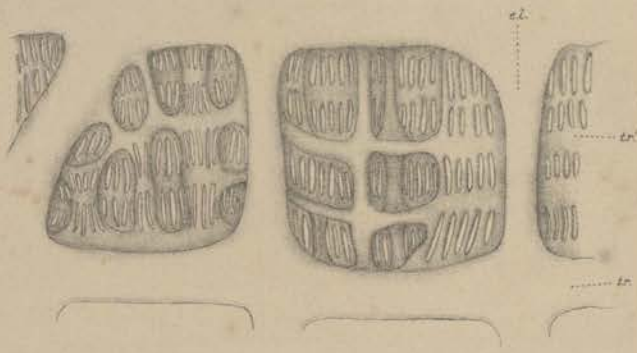

Fig. 5.

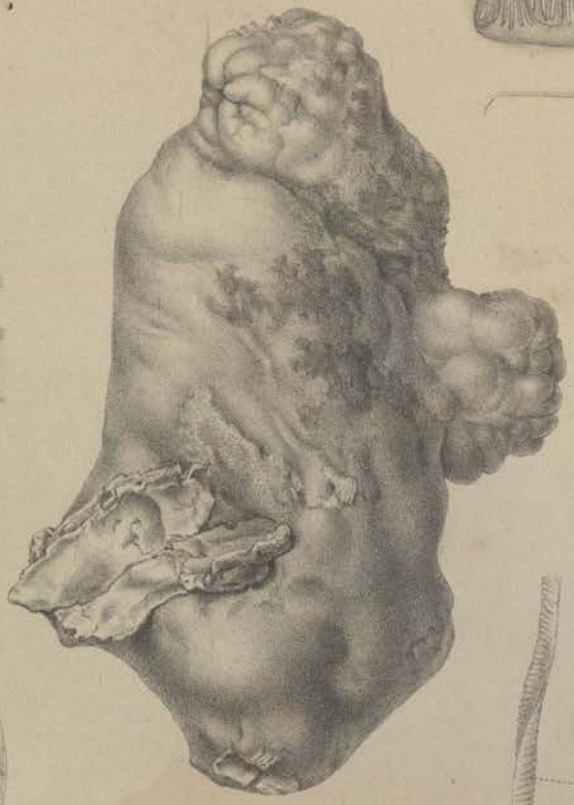

Fig. 7.

Fig. 9.

Fig. 6.

Fig. 11.

Fig. 10.

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FIGS. 1-5 PACHYCHLAENA OBESA, Herdman. FIGS. 6-11 P. GIGANTEA, Herdman.

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PLATE XXIX.

PLATE XXIX.

Figs. 1–9. *Pachychlæna oblonga*, Herdman.
Fig. 10. *Pachychlæna gigantea*, Herdman.

Fig. 1. *Pachychlæna oblonga*, from the right side; natural size.

Fig. 2. The same, from the ventral edge; natural size.

Fig. 3. A small portion of a section through the peripheral layer of test, showing the terminal knobs of the blood-vessels, the pigment cells, &c.; magnified (Hartn., obj. 4).

Fig. 4. Part of the branchial sac of *Pachychlæna oblonga*, seen from the interior; magnified (Hartn., obj. 4).

Fig. 5. A small portion of the last figure; more enlarged (Hartn., obj. 5).

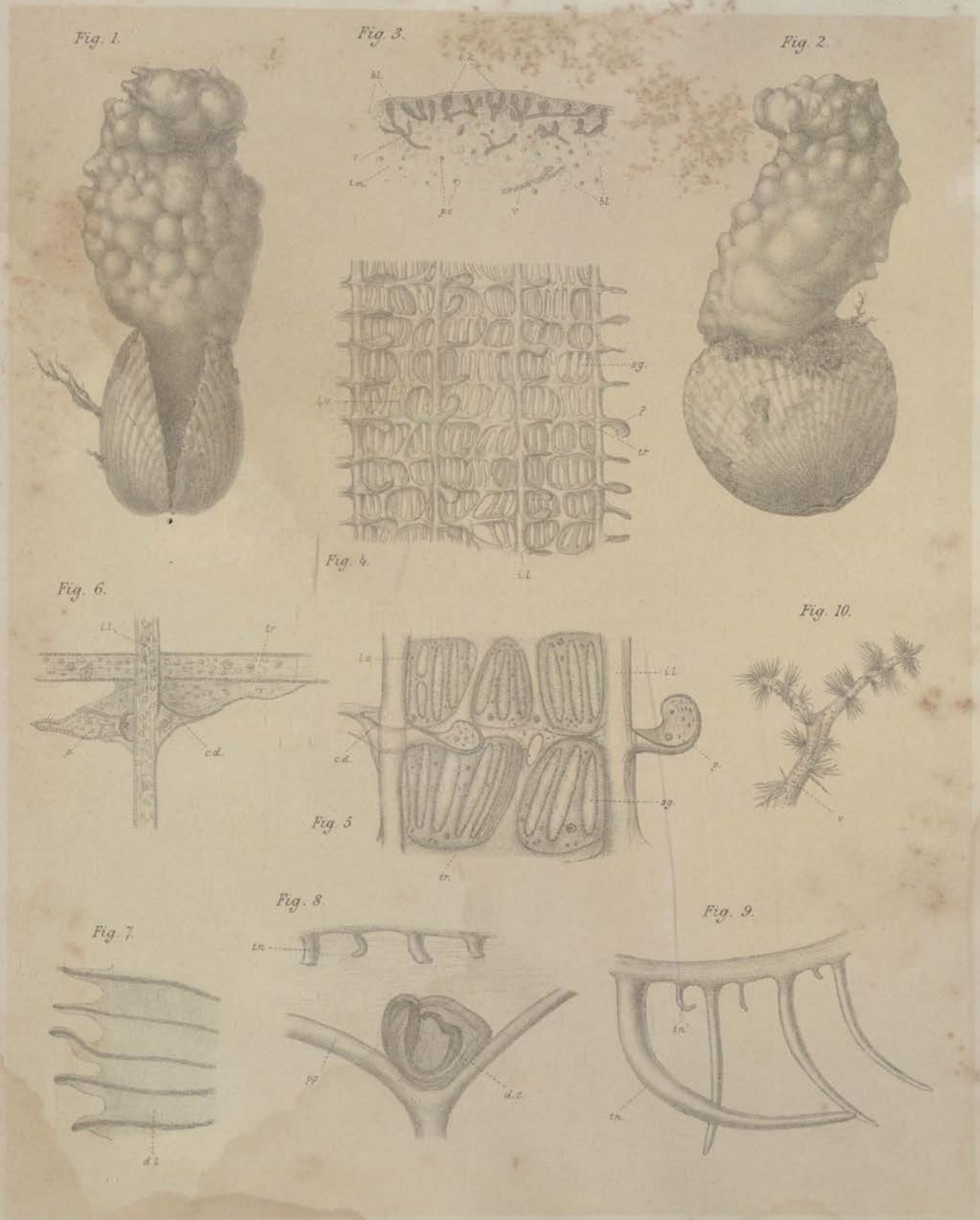
Fig. 6. A small portion of the same branchial sac, showing a papilla edge-ways, an internal longitudinal vessel, a connecting duct, and a transverse vessel; much magnified (Hartn., obj. 5).

Fig. 7. A part of the dorsal lamina; magnified (Hartn., obj. 4).

Fig. 8. The dorsal part of the anterior end of the branchial sac of *Pachychlæna oblonga*, showing the dorsal tubercle, the peripharyngeal band, and the bases of the tentacles; magnified (Hartn., obj. 4).

Fig. 9. Part of the tentacular circlet of *Pachychlæna oblonga*; magnified (Hartn., obj. 4).

Fig. 10. Terminal twigs of the blood-vessels in the test of *Pachychlæna gigantea*, showing crystals attached to their outer walls (Hartn., obj. 7).



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FIGS. 1-9 PACHYCHLAENA OBLONGA, Herdman. FIG. 10 P. GIGANTEA, Herdman.

PLATE XXX.

PLATE XXX.

Ascidia challengeri, n. sp.

Fig. 1. *Ascidia challengeri*, a large specimen, seen from the right side; natural size.

Fig. 2. A much younger specimen, from the right side; natural size.

Fig. 3. Part of a section through the test of *Ascidia challengeri*, showing vessels (*v.*), bladder cells (*bl.*), &c.; magnified (Hartn., obj. 4).

Fig. 4. Part of the branchial sac, seen from the inside; magnified (Hartn., obj. 4).

Fig. 5. Part of the dorsal lamina of *Ascidia challengeri*, seen from the left side; magnified (Hartn., obj. 4).

Fig. 6. Another part of the same dorsal lamina, with a crenated and toothed edge, seen from the left side; magnified (Hartn., obj. 4).

Fig. 7. Another part of the same dorsal lamina, near the base, where it is wide and has strongly marked ribs; seen from the right side; magnified (Hartn., obj. 4).

Fig. 8. The dorsal part of the anterior end of the branchial sac, showing the dorsal tubercle (*d.t.*), the præbranchial zone, with muscle bands (*m.b.*) showing through, and two of the large tentacles (*tn.*); magnified (Hartn., obj. 5).

Fig. 8.

Fig. 1.

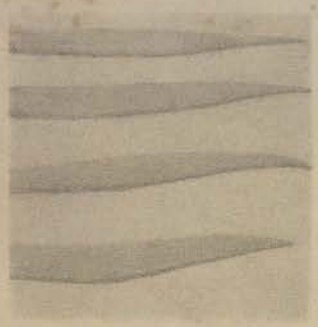


Fig. 7.

Fig. 6.

Fig. 5.

Fig. 2.

Fig. 3.

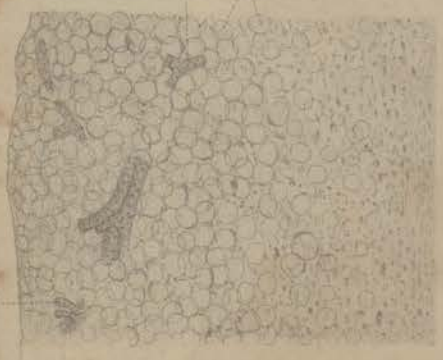
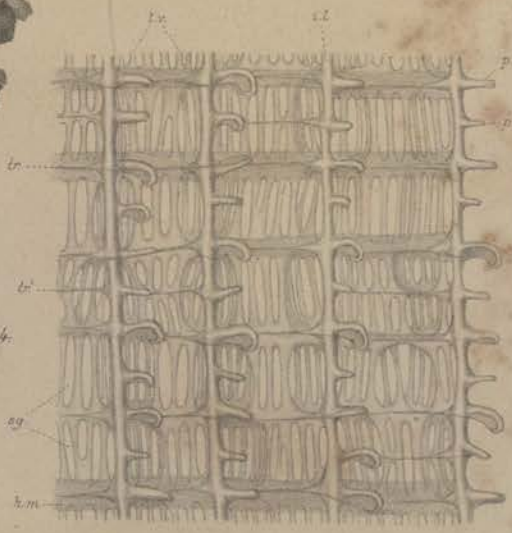


Fig. 4.



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ASCIDIA CHALLENGERI, n. sp.

PLATE XXXI.

PLATE XXXI.

Figs. 1–3. *Ascidia placenta*, Herdman.
Figs. 4–8. *Ascidia meridionalis*, Herdman.

Fig. 1. *Ascidia placenta*, seen from the right side ; natural size.

Fig. 2. Part of the branchial sac of *Ascidia placenta*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 3. Part of the dorsal lamina of the same species ; magnified (Hartn., obj. 4).

Fig. 4. *Ascidia meridionalis*, seen from the right side ; natural size.

Fig. 5. Part of the branchial sac of *Ascidia meridionalis*, seen from the outside, and showing the attachment of one of the "connectives" (*s.*) to a transverse vessel ; magnified (Hartn., obj. 4).

Fig. 6. Part of the same branchial sac, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 7. Part of the dorsal lamina of *Ascidia meridionalis* ; magnified (Hartn., obj. 4).

Fig. 8. The dorsal part of the anterior end of the same branchial sac, showing the dorsal tubercle (*d.t.*), the præbranchial zone with muscle bands showing through, and three of the tentacles, one long (*tn.*) and two short (*tn.'*) ; magnified (Hartn., obj. 4).

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

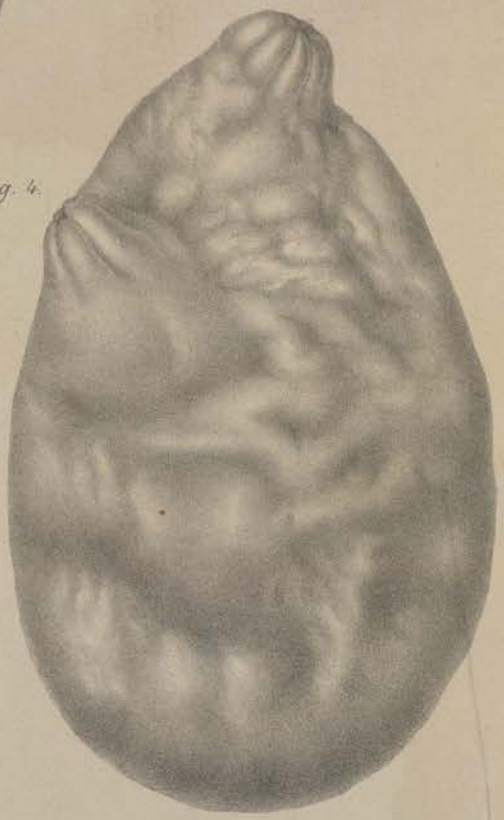


Fig. 7.

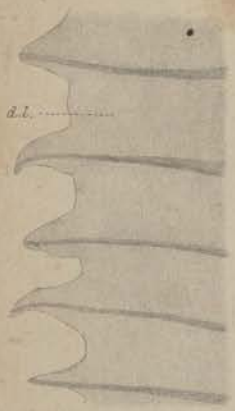


Fig. 8.

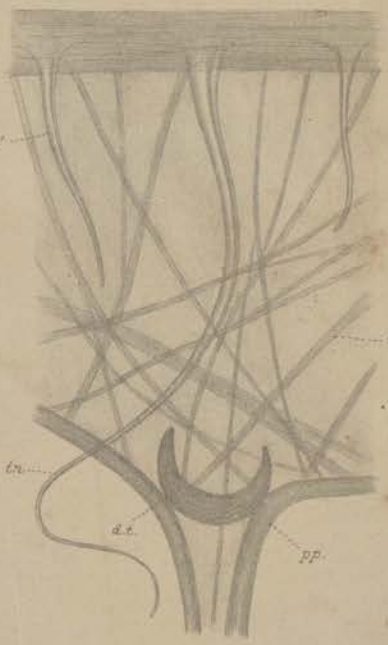


Fig. 6.

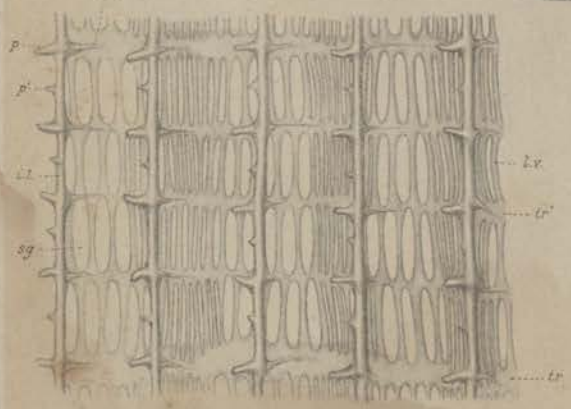
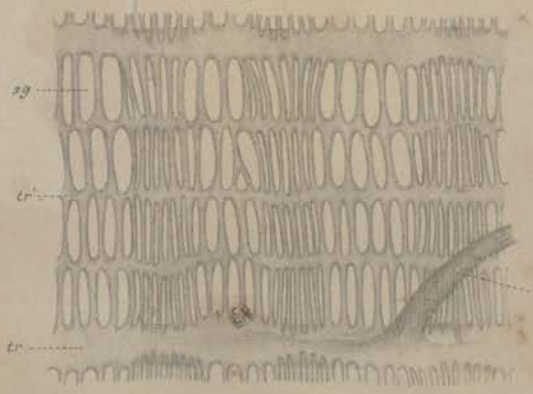


Fig. 5.



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FIGS. 1-3 ASCIDIA PLACENTA, Herdman. FIGS. 4-8 ASCIDIA MERIDIONALIS, Herdman.

PLATE XXXII.

PLATE XXXII.

Figs. 1–6. *Ascidia falcigera*, Herdman.
Figs. 7–10. *Ascidia tenera*, Herdman.

Fig. 1. *Ascidia falcigera*, from the right side ; natural size.

Fig. 2. Another specimen of the same species, from the right side ; natural size.

Fig. 3. Part of the branchial sac of *Ascidia falcigera*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 4. Part of the dorsal lamina of the same species ; magnified (Hartn., obj. 4).

Fig. 5. Part of the tentacular circlet; magnified (Hartn., obj. 4).

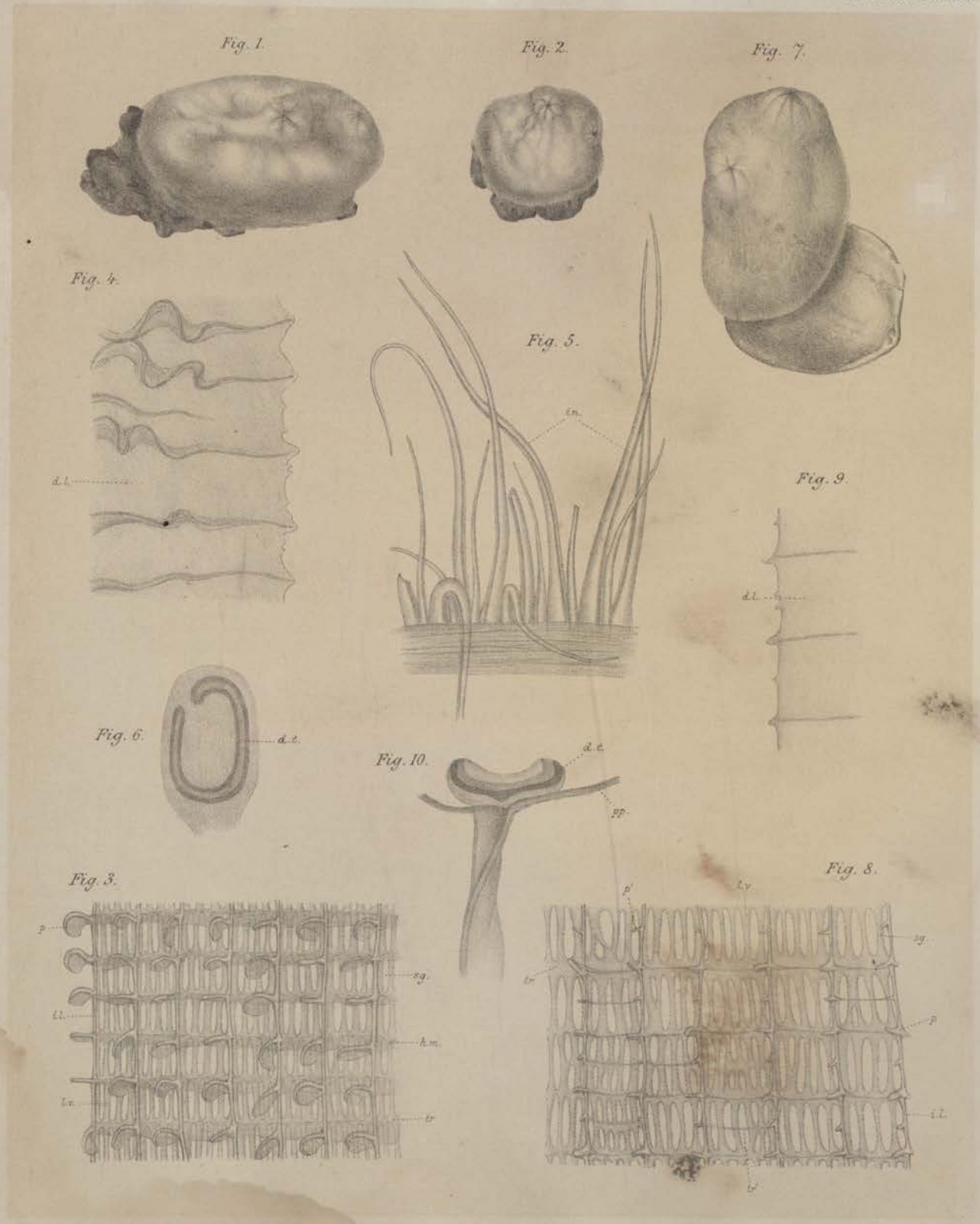
Fig. 6. The dorsal tubercle of *Ascidia falcigera*; magnified (Hartn., obj. 4).

Fig. 7. *Ascidia tenera*, from the right side ; natural size.

Fig. 8. Part of the branchial sac of *Ascidia tenera*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 9. Part of the dorsal lamina of the same species ; magnified (Hartn., obj. 4).

Fig. 10. The dorsal tubercle and peripharyngeal band of *Ascidia tenera*; magnified (Hartn., obj. 4).



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F. Huth, Lith^r Edin^r

FIG^s 1-6 ASCIDIA FALCIGERA, Herdman. FIG^s 7-10 ASCIDIA TENERA, Herdman.

PLATE XXXIII.

PLATE XXXIII.

Figs. 1–6. *Ascidia translucida*, Herdman.
Figs. 7–9. *Ascidia cylindracea*, Herdman.
Figs. 10–12. *Ascidia despecta*, Herdman.

Fig. 1. *Ascidia translucida*, from the right side ; natural size.

Fig. 2. The same from the left side, showing the vascular ramifications in the test; natural size.

Fig. 3. Part of the branchial sac of *Ascidia translucida*, seen from the outside, and showing "minute plication" ; magnified (Hartn., obj. 4).

Fig. 4. Part of the same branchial sac, seen from the inside ; magnified (Hartn., obj, 4).

Fig. 5. The tentacles and the dorsal tubercle, &c., of *Ascidia translucida;* magnified (Hartn., obj. 4).

Fig. 6. Part of the dorsal lamina of the same species ; magnified (Hartn., obj. 4).

Fig. 7. *Ascidia cylindracea*, from the right side ; natural size.

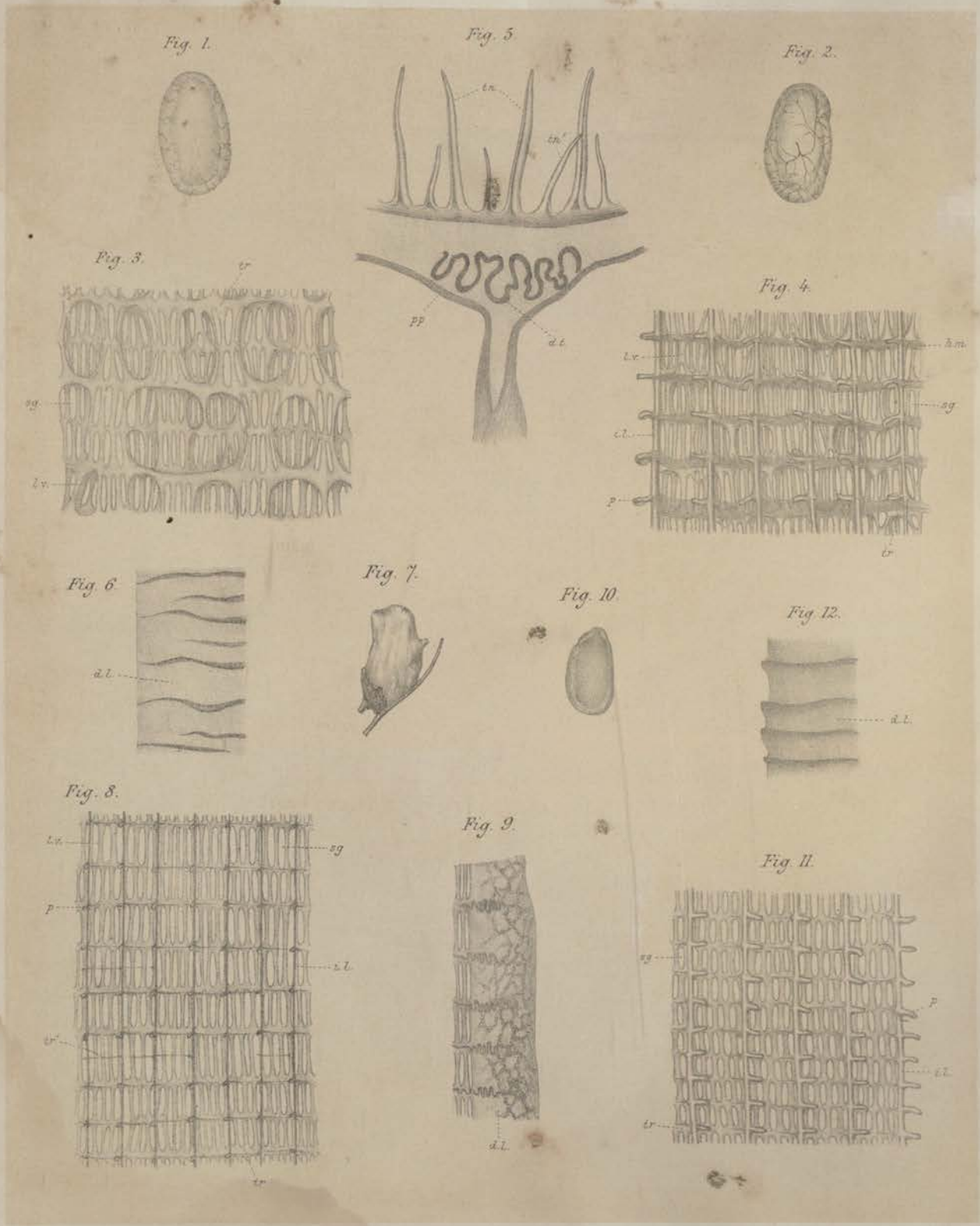
Fig. 8. Part of the branchial sac of *Ascidia cylindracea*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 9. Part of the dorsal lamina of the same species, showing the sinuses engorged with blood corpuscles ; magnified.

Fig. 10. *Ascidia despecta*, from the right side ; natural size.

Fig. 11. Part of the branchial sac of *Ascidia despecta*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 12. Part of the dorsal lamina of the same species ; magnified (Hartn., obj. 4).



W. A. Herdman del.

F. Huth, Lith^r Edin^r

FIG^s 1-6 ASCIDIA TRANSLUCIDA, Herdman. FIG^s 7-9 A. CYLINDRACEA, Herdman. FIG^s 10-12 A. DESPECTA, Herdman.

PLATE XXXIV.

PLATE XXXIV.

Figs. 1–6. *Ascidia pyriformis*, Herdman.
Figs. 7–10. *Ciona flemingi*, Herdman.

Fig. 1. *Ascidia pyriformis*, from the right side ; natural size.

Fig. 2. The same specimen from the left side ; natural size.

Fig. 3. Another specimen with the test removed, seen from the right side, showing the shape of the body, the siphons, &c. ; natural size.

Fig. 4. Part of the branchial sac of *Ascidia pyriformis*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 5. The dorsal tubercle of the same species ; magnified (Hartn., obj. 4).

Fig. 6. Part of the dorsal lamina of *Ascidia pyriformis* ; magnified (Hartn., obj. 4).

Fig. 7. *Ciona flemingi*, from the right side ; natural size.

Fig. 8. Part of the branchial sac of *Ciona flemingi*, seen from the inside ; magnified (Hartn., obj. 4).

Fig. 9. Part of the series of dorsal languets of the same species ; magnified (Hartn., obj. 4).

Fig. 10. The dorsal tubercle of the same species ; slightly enlarged.

Fig. 1.

Fig. 7.

Fig. 10.

Fig. 2.

Fig. 3.

Fig. 9.

Fig. 6.

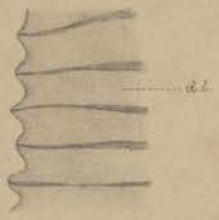


Fig. 4.

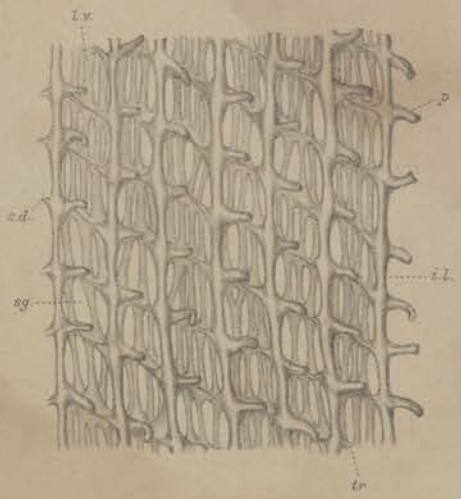
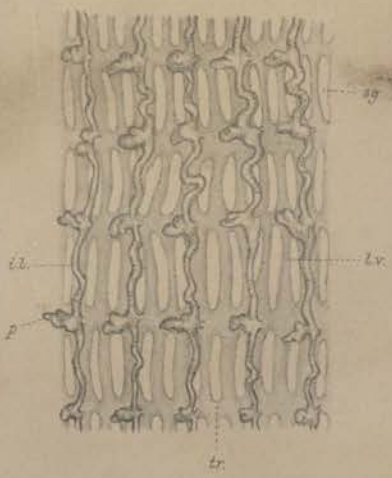


Fig. 5.

Fig. 8.



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FIGS. 1-6 ASCIDIA PYRIFORMIS, Herdman. FIGS. 7-10 CIONA FLEMINGI, Herdman.

PLATE XXXV.

PLATE XXXV.

Figs. 1 and 2. *Ciona savignyi*, n. sp.
Figs. 3–5. *Clavelina enormis*, Herdman.
Figs. 6–10. *Clavelina oblonga*, Herdman.

Fig. 1. *Ciona savignyi*; natural size.

Fig. 2. Part of the branchial sac of *Ciona savignyi*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 3. A colony of *Clavelina enormis*; natural size.

Fig. 4. Part of the branchial sac of *Clavelina enormis*, seen from the inside; magnified (Hartn., obj 4).

Fig. 5. Part of the dorsal lamina of the same species, showing the large triangular languets (*l.*); magnified (Hartn., obj. 4).

Fig. 6. A colony of *Clavelina oblonga*; natural size.

Fig. 7. Part of the branchial sac of *Clavelina oblonga*, seen from the inside; magnified (Hartn., obj 4).

Fig. 8. The dorsal part of the branchial sac of *Clavelina oblonga*, seen from the inside, showing some of the languets (*l.*); magnified (Hartn., obj. 4).

Fig. 9. Part of the same branchial sac, seen from the inside; much magnified (Hartn., obj. 5).

Fig. 10. Part of the tentacular circlet of *Clavelina oblonga*, showing large and small tentacles; magnified (Hartn., obj. 4).

Fig. 2.

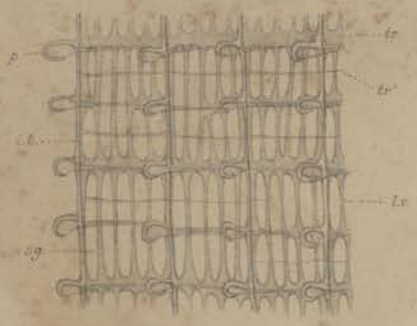


Fig. 1.

Fig. 4.

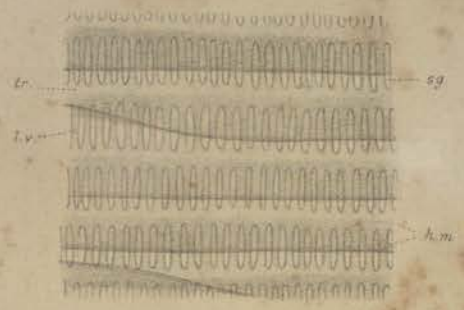


Fig. 3.

Fig. 5.

Fig. 9.

Fig. 10.

Fig. 6.

Fig. 7.

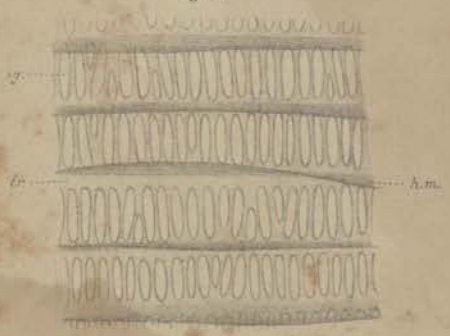
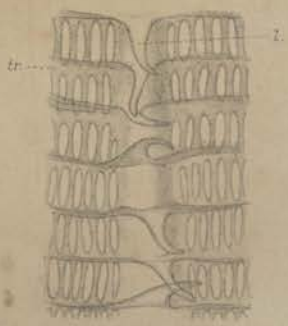


Fig. 8.



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FIGS. 1-2 CIONA SAVIGNYI, n.sp. FIGS. 3-5 CLAVELINA ENORMIS, Herdman.

FIGS. 6-10 CLAVELINA OBLONGA, Herdman.

PLATE XXXVI.

PLATE XXXVI.

Figs. 1–6. *Ecteinascidia turbinata*, Herdman.
Figs. 7–11. *Ecteinascidia fusca*, Herdman.
Figs. 12–14. *Ecteinascidia crassa*, Herdman.

Fig. 1. A large colony of *Ecteinascidia turbinata*; natural size.

Fig. 2. Three individuals from the same colony, showing the stolons; natural size.

Fig. 3. Part of the branchial sac of *Ecteinascidia turbinata*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 4. Part of the circle of tentacles of the same species, showing three sizes (*tn.*, *tn.'* and *tn.''*); magnified (Hartn., obj. 4).

Fig. 5. The viscera on the left side of the mantle in *Ecteinascidia turbinata*, showing the relations of the genital glands; slightly enlarged.

Fig. 6. The dorsal part of the branchial sac of the same species, seen from the inside, showing the tentacular languets (*l.*) and the rudimentary connective ducts (*c.d.*); magnified (Hartn., obj. 4).

Fig. 7. *Ecteinascidia fusca*, seen from the right side; natural size.

Fig. 8. Part of the branchial sac of *Ecteinascidia fusca*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 9. A small part of the branchial sac of *Ecteinascidia fusca*; much enlarged (Hartn., obj. 7).

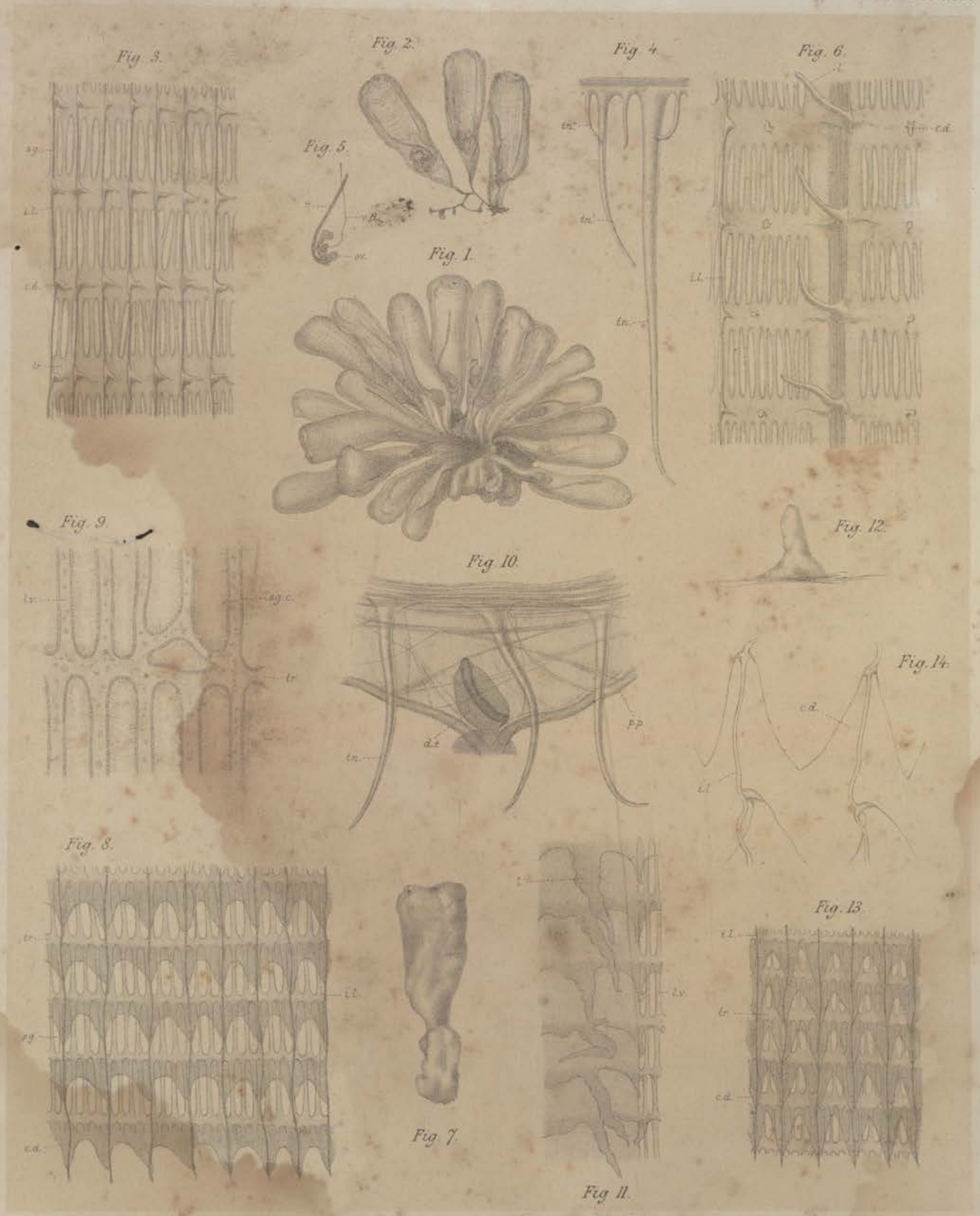
Fig. 10. Part of the dorsal region of the anterior end of the same branchial sac, showing the dorsal tubercle (*d.t.*), the præbranchial zone, and three of the tentacles (*tn.*); magnified (Hartn., obj. 4).

Fig. 11. Part of the dorsal region of the branchial sac of *Ecteinascidia fusca*, showing the languets; magnified (Hartn., obj. 4).

Fig. 12. *Ecteinascidia crassa*; natural size.

Fig. 13. Part of the branchial sac of *Ecteinascidia crassa*, seen from the inside; magnified (Hartn., obj. 4).

Fig. 14. The internal longitudinal bars (*i.l.*) and their connecting ducts (*c.d.*), from the branchial sac of *Ecteinascidia crassa*; much enlarged (Hartn., obj. 5).



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FIGS. 1-6 ECTEINASCIDIA TURBINATA, Herdman. FIGS. 7-11 E. FUSCA, Herdman.
FIGS. 12-14 E. CRASSA, Herdman.

PLATE XXXVII.

PLATE XXXVII.

Figs. 1–5. *Hypobythius calycodes*, Moseley.
Figs. 6–9. *Hypobythius moseleyi*, n. sp.

Fig. 1. *Hypobythius calycodes*, seen from the ventral surface, and showing the body and peduncle, the cartilaginous thickenings of the test (*t.t.*), the branchial (*br.*) and atrial (*at.*) apertures, and most of the internal organs; half the natural size. (From a drawing by Professor H. N. Moseley.)

Fig. 2. Outline of the dorsal side of the body of *Hypobythius calycodes*, to show the atrial aperture (*at.*), and the symmetrical arrangement of the nodules of thickened test (*t.t.*); much reduced. (From a drawing by Professor H. N. Moseley.)

Fig. 3. A small portion of the mantle of the same species, to show the arrangement of the muscle bands (*m.b.*); magnified (Hartn., obj. 4).

Fig. 4. Part of the branchial sac of *Hypobythius calycodes*, showing the rounded stigmata (*sg.*) formed by the irregular vessels (*tr.*); magnified (Hartn., obj. 4).

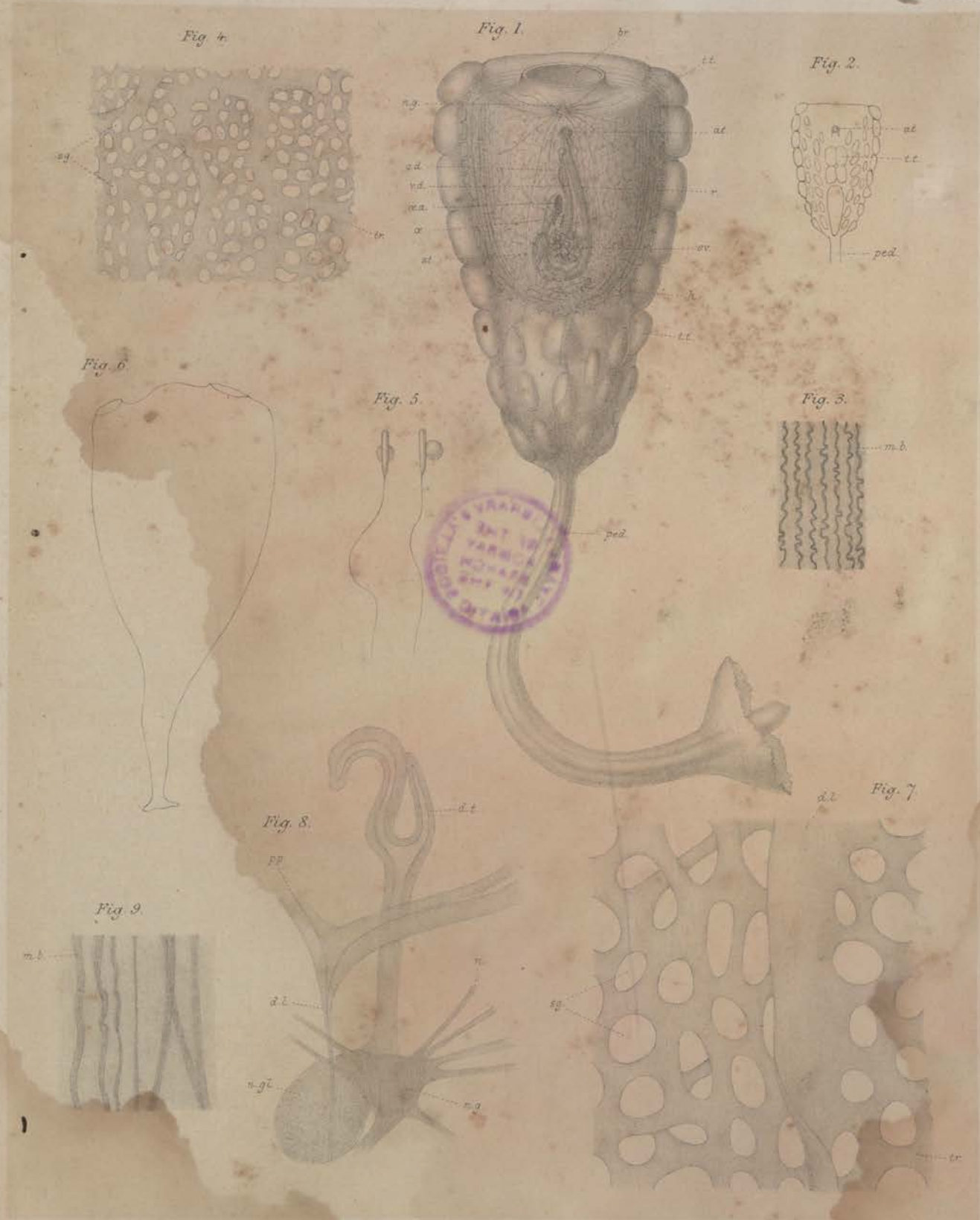
Fig. 5. Two spermatozoa (one seen sideways) of *Hypobythius calycodes*; much magnified. (From a drawing by Professor H. N. Moseley.)

Fig. 6. Outline of the body of *Hypobythius moseleyi*; about the natural size.

Fig. 7. The dorsal part of the branchial sac of *Hypobythius moseleyi*, showing the stigmata (*sg.*), and the dorsal lamina (*d.l.*); magnified (Hartn., obj. 5).

Fig. 8. The dorsal region of the anterior end of the branchial sac of *Hypobythius moseleyi*, showing the dorsal tubercle (*d.t.*), the nerve ganglion (*n.g.*), the neural gland (*n.gl.*) the peripharyngeal bands (*p.p.*), and the commencement of the dorsal lamina (*d.l.*); much magnified (Hartn., obj. 5).

Fig. 9. Part of the mantle of *Hypobythius moseleyi*, showing the arrangement of the muscle bands (*m.b.*); magnified (Hartn., obj. 4).



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FIGS. 1-5 HYPOBYTHIUS CALYCODES, Moseley. FIGS. 6-9 HYPOBYTHIUS MOSELEYI, Herdman.

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